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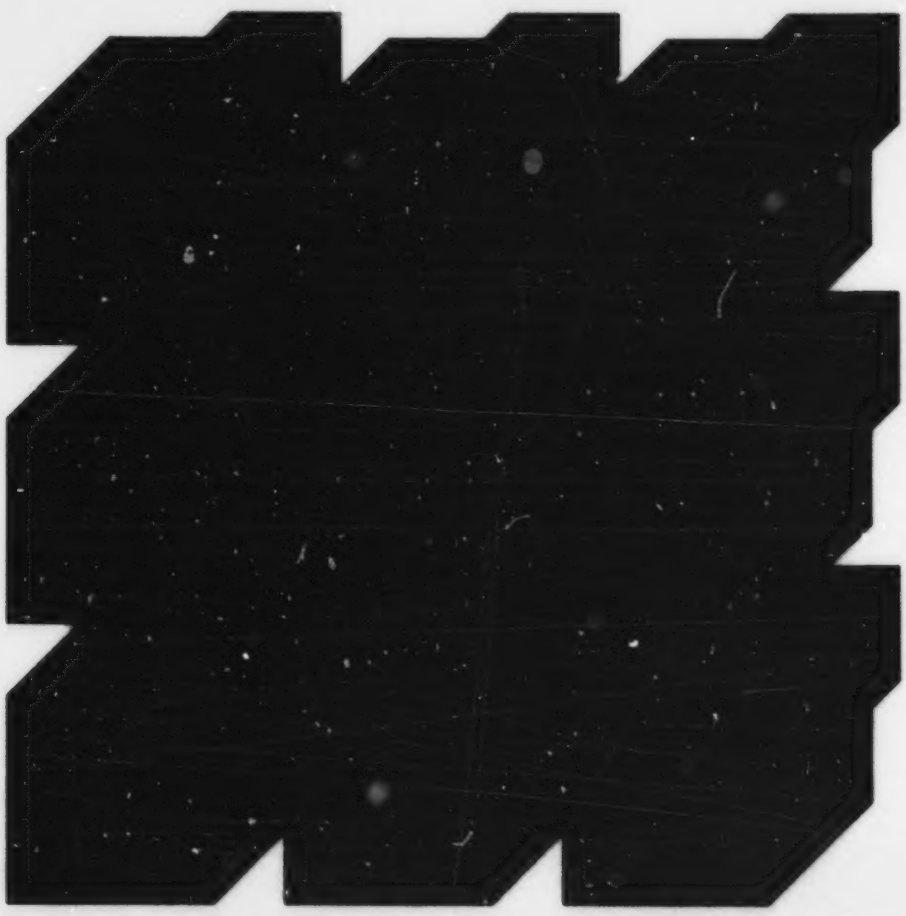

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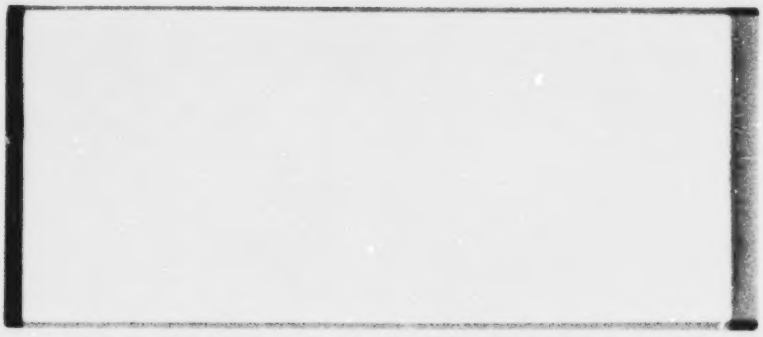

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DISCUSSION PAPER NO. 278

Western Canada's Coal Industry: Status and Potential

by Brenda J. Dyack

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RÉSUMÉ

Le présent document a été préparé en vue du rapport du Conseil économique du Canada intitulé L'Ouest en transition et publié en 1984. Les ressources charbonnières se sont révélées importantes pour l'Ouest canadien, et l'auteure du document a cherché à savoir dans quelle mesure elles le sont encore et contribueront éventuellement à la croissance économique de la région. Elle examine la situation actuelle de l'industrie du charbon ainsi que les principaux problèmes qui se posent pour sa croissance. Très tôt au cours de ses recherches, il lui est apparu que, même si l'Ouest possède de vastes réserves de charbon, elles n'ont pas été d'un apport considérable à la croissance économique. L'auteure a constaté que l'industrie connaît un certain nombre de problèmes qui peuvent éroder les gains de revenu réel de cette industrie.

L'analyse de la situation montre que la croissance des revenus attribuable au développement des ressources charbonnières sera modeste, surtout à cause des prévisions pessimistes quant à l'augmentation des prix réels du charbon. L'auteure précise les changements qui permettraient peut-être d'améliorer ces perspectives. Elle examine les modifications qu'il serait avantageux d'apporter dans la gestion des stocks de charbon exportables, les obligations fiscales et le régime des prix du charbon écoulé au Canada. Ces changements

auraient pour but d'empêcher les transferts de revenus réels des Canadiens et les pertes de revenu découlant de pratiques inefficaces.

C'est l'aspect demande du marché d'exportation qui peut entraîner de graves pertes de revenus réels pour l'Ouest. Voilà pourquoi l'auteure étudie ce problème en profondeur et examine un certain nombre de mesures préventives. Dans la section V, elle présente et analyse effectivement une option optimale comportant des abattements fiscaux ou des subventions.

Ce document porte principalement sur le marché d'exportation et la production de revenus réels dans l'industrie du charbon, mais il examine aussi deux problèmes internes de ce secteur. L'un concerne le charbon consommé au Canada par les centrales thermiques de production d'électricité et, plus précisément, la fixation de son prix à une valeur autre que son coût d'option. L'autre a trait au taux d'imposition des recettes selon des méthodes pouvant causer des distorsions indésirables. Comme solution de rechange, l'auteure suggère une taxe sur les profits.

ABSTRACT

This paper was prepared as background for the 1984 Economic Council of Canada publication, Western Transition. Canada's coal resource was identified as one which has been important in Western Canada and our questions concerned the extent of this importance and whether it would translate into Western economic growth in the future. This paper investigates the status of the coal industry and the major problems that interfere with growth. It was recognized early in our research that although the West possesses extensive reserves of coal there has not been a major contribution to economic growth. We also found that the industry is experiencing a number of problems which have the power to erode the real income gains that are contributed by the resource.

Our review indicates that the prospects for future income growth associated with coal developments are modest mainly because of the pessimistic outlook for future real price increases for coal. Our discussion identifies changes that could be made to improve this outlook. We investigate beneficial changes in the management of exportable coal resources, tax structures and pricing of domestically-used coal. The goal of any change would be the prevention of real income transfers from Canadians and income losses through inefficient practices.

It is the demand-side power in the export market that can lead to serious real income losses from the West and therefore we analyze this problem extensively and investigate a number of preventative measures. An optimal tax or subsidy option is formally presented and analyzed in Section V as one possible solution.

Although the emphasis in this paper is placed on the export market and real income generation in this sector we do discuss two domestic industry problems. One is the pricing of coal used domestically for thermal electri-

city generation at some value other than its opportunity cost. The other concerns the taxation of coal revenues using methods which can cause undesirable distortions. A profits tax is offered as an alternative.

ACKNOWLEDGEMENTS

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I INTRODUCTION

Coal mining has been an established activity in Western Canada since the 19th century. Organized mining operations were established before the turn of this century in each of Saskatchewan, Alberta and British Columbia. Initial demand was for coal as a space heating fuel and as a fuel for steam locomotives. Production grew in all provinces but by 1940 the industry had begun to exhibit a clear decline in British Columbia with mine closings and production declines. In Alberta the 1950s marked the period of most serious decline while Saskatchewan's production stabilized during this period.

The decline of coal was associated with the substitution of oil, natural gas, and propane for coal in its rail and home heating markets. During the 1960s, however, coal experienced a renaissance with the expansion of coal-fired electricity generating plants in Saskatchewan and Alberta. With the growing electricity demands of a fast growing population particularly in Alberta, coal demand also grew. Demand growth for metallurgical coal in Japan also contributed to the resurgence of the coal industry in Alberta and British Columbia. Marked increases in demand began in the late 1960s and after the early 1970s oil price shock export demand for thermal coal also contributed to increased Canadian activity. Increased production in all three provinces has been pronounced since the late 1960s. The more recent oil glut and world-wide recession have contributed to revisions of the optimistic forecasts of industry growth which were made only a short while ago. Both thermal and especially metallurgical coal markets are currently viewed pessimistically and this applies to both domestic western and offshore demand.

The recent decline in the rate of growth of the coal industry has drawn attention to certain questions that we feel are worthwhile addressing.

For instance, how important has the coal industry really been? What sort of contribution has the industry made to Western growth? What has caused the recent declines in the industry and what is the cost of decline? Since coal is a natural resource we have found it useful to view the industry's growth within the general framework of the 'staple-based' growth of Western Canada. As such we recognize that coal is only one of a number of resources responsible for Western growth. For example, agriculture on the prairies provided the wheat boom in the early 1900s, forestry generated growth throughout the 20th century in British Columbia and more recently, growth has been oil-fed in Alberta. These 'staples' which provided a basis for economic growth in the West have in common a low level of processing and a market which is predominantly outside the West. The real income growth generated in the staple-based industries was determined by certain factors or more precisely, prerequisites to real growth. These are: (1) increases in relative prices; (2) increases in the domestic resource base for use in the current period; and (3) increases in productivity (technological change) in production. One or more of these three factors has been responsible for the traditional staple booms in the West.

In this paper we consider the past growth of coal and its contribution to economic growth and the potential for further coal-based growth in the West. Part of our interest is with the problems encountered by the industry. Many of these hinge on the characteristics of the international market for coal where demand is concentrated in very few countries while many producers must compete for markets.

Coal is important partly because of the size of relatively low cost reserves[1] concentrated in the West relative to the rest of the world and also because of the prospect for growth of thermal coal demand because of

substitution away from oil-based electricity generation. Other required inputs to mineral production such as skilled labour, water resources and required infrastructure also are available in the West and contribute to a favourable outlook. Growth constraints do exist, however, and some of these are beyond the control of the West. Others are a function of the institutional environment or other factors for which we do have some control. We consider both kinds of constraint and where possible, prescribe remedies. Removing constraints and inefficiencies and better management of the West's market disadvantages and advantages may help to improve the long-run growth potential for coal.

We recognize very early in the discussion that Western minerals industries, including the coal industry, have not made a contribution comparable in magnitude to that made by the oil and gas industry in the West. But given the exhaustibility of non-renewable resources it is reasonable to ask if there is any other staple, or more specifically, any mineral, which will be developed to take petroleum's place as a generator of income and employment. Or must the West depend on expansion of other sectors or even decline. Without perfect foresight and a sophisticated general model of the economy and world demand we must take a partial approach and consider mineral industries individually and make qualitative predictions of growth potential for each. For this paper we have structured our analysis around the prospects for changes in each of the three prerequisites to growth for the coal industry and the extent to which these prospects can be adapted to the advantage of the West.

Initially we show that coal resources are extensive indeed in the West. An account of recent growth in industry activity is followed by a general analysis of the importance of this growth in terms of provincial

income and employment. A review of coal price trends indicates the basis of income growth. The prospects for future growth in demand and in coal prices follows naturally from the review of market structure and the mechanism for price determination for coal. We find that there are poor prospects for very large growth in the economic importance of the coal industry in the West. As a result of this view we concentrate less on the predictions of future growth based on the status quo and more on the reasons for the current industry problems. The ultimate goal of our review is to make recommendations for the better management of the West's coal resources in light of the extent and quality of the West's resources as well as the particular characteristics of international coal markets.

II THE EXTENT OF WESTERN COAL RESOURCES AND RESERVES

Coal resources in Western Canada are extensive with the West accounting for virtually all of Canada's resources and recoverable reserves.[2] Energy Mines and Resources, Canada has estimated that B.C. has almost half of Canada's recoverable reserves, while Alberta and Saskatchewan share one half almost equally. Although these estimates indicate that the West is relatively well-endowed with coal, the full extent of Western coal is underestimated for at least two reasons. First, Western coal and particularly mountain coal is high quality coal but the tonnages themselves say little about the quality of each tonne in terms of heating value for thermal coal, for example, or in terms of carbon content and fluidity for coking coals.[3] Secondly, not enough of the West has been explored or developed sufficiently to make estimates of true ultimate potentials. In the East, the region is much smaller and coalfields more accessible for exploration while in the West vast regions in the mountains remain untouched or at least inadequately explored. Given markets, prices and the extent of already discovered but undeveloped fields, there has been insufficient incentive to delineate resources more extensively. There has been renewed activity in coal since the 1950s, however, and this is related to increased use of coal in thermal electricity plants and since the 1960s because of offshore demand for thermal and coking coal. This activity has been responsible for the delineation of a number of major coalfields in the West.

All ranks of coal can be found in the West with Alberta having significant reserves of all types, Saskatchewan having only lignite and B.C. having mainly bituminous coal.[4] The quality of the thermal coal in terms of heating value[5] per kilogram increases from east to west with lignite having

the lowest and the high volatile bituminous coals of Alberta foothills and the mountains of Alberta and B.C. having the highest.

Metallurgical coal occurs in the mountain regions of Alberta and B.C. Since high quality thermal and metallurgical coals are low in moisture Saskatchewan's lignite is lowest quality with its high moisture content and B.C. bituminous and anthracite are the highest quality. All Western coal is relatively low in sulphur content which is necessary for high quality thermal and coking coals. The ash, or waste, content of Western coal varies. Based on recoverable coal before treatment ash content tends to be low for lignite because the coal occurs in regular, generally horizontal seams which can be exploited in such a way that the waste is left behind. B.C. tends to have higher proportions of ash and Alberta coals can have either very low or quite high ash contents. Coal destined for mine-mouth thermal plants is not cleaned or prepared in any intensive way but coals destined for shipment are typically treated to reduce both ash and moisture. Cleaning in turn reduces impurity content which would otherwise increase the costs of transportation and ash disposal and affect the performance of the coal in its various uses. For example, a B.C. coal may be estimated to have between 17 and 30 per cent ash when measured as a resource but have only between 9 and 22 per cent ash when delivered to the customer.[6]

For our purposes we will typically refer to coal as being thermal or metallurgical and as either relatively high quality or low quality. To be more precise would cloud the general statements with detail. Resource estimates reported by both EMR, Canada and the provinces differ according to definitions and sometimes cover different coalfields. Rather than comparing estimates as a geologist might we report both while we generally accept that coal resource endowments are large in the West. We are more concerned with

the factors which determine coal's value to Westerners. As a quick introduction this section has thus far noted the very general characteristics of the vast Western coal resource. We continue this overview of coal with a note on resources in each province.

All of Saskatchewan's coal resources are of the lowest quality in Western Canada although it too shares the low sulphur content typical of Western coal. The coal is lignite which is relatively high in moisture and low in energy content. The coal is suitable for mine-mouth use at thermal electric plants. Federal estimates indicate that total resources of immediate interest exist in four coalfields in the south of the province. Of the 4.2×10^9 tonnes it is estimated that 2.1×10^9 tonnes occur in seams mineable with current technology and 1.7×10^9 tonnes is recoverable as raw coal at the mines. Recoverable coal reserves represent over two hundred years supply at current production levels. The coal is not specified as clean coal since it is used directly at mine-mouth thermal plants. The coal's bulk and moisture, qualities which makes it susceptible to spontaneous combustion, reduce its value as an export commodity. Sodium content of the coal varies within the region and also reduces the quality of the coal. Table 2 shows Saskatchewan's recoverable coal and coalfields ranked by size.

Alberta's coal resources are of two basis types[7] - subbituminous coal, used for thermal electricity generation and which occurs only in the plains region, and bituminous coal. Metallurgical bituminous coal occurs in the mountain region while non-agglomerating thermal bituminous coal occurs in the Foothills region and also in the Lethbridge Field of the plains. The energy content and fixed carbon content of Alberta coals increase from east to west indicating increasing quality of the coal. Moisture content falls from east to west which also contributes to the higher quality of Mountain

and Foothills coal. Ash content, however, increases for these coals lowering their relative values.

Thermal coal from the plains is typically used directly in mine-mouth thermal plants with no upgrading or treatment. Coal of all ranks which is destined for export is upgraded (beneficiated) to increase quality or in other words, reduce the waste content of the coal. Also, coal consumers typically require coal with certain quality specifications that match the technology they use in steam raising in thermal plants or coke production and therefore coal is beneficiated to meet certain standards.

The Energy Resources Conservation Board's (ERCB's) most recent estimate of coal resources indicates that coal established resources total about 52×10^9 tonnes. 18×10^9 tonnes of this coal is judged to be recoverable with current mining technology and current and foreseeable economic conditions. 1.7×10^9 tonnes of the total is judged to be within the boundaries of the regions in which coal can be developed in Alberta. Other areas are protected because of environment or social reasons according to Alberta's coal policy.[8] 1.7×10^9 tonnes is the amount of coal which is judged to be available unless economic conditions change drastically or technological changes take place.[9] The assumption also is made that policy will not change to either restrict or allow greater access to coal volumes as identified in the total reserve estimate. (Table 3) Reserves in mine permit areas represent almost one hundred years supply at current production levels.

B.C. is endowed with all ranks of coal. The Hat Creek coalfield has as much lignite (and includes subbituminous as well) as Saskatchewan's largest field. High quality thermal coal occurs in the Groundhog coalfield as semi-anthracite. The southeast and northeast (Peace River district) coalfields contain both thermal and metallurgical coal with the southeast

producing both types now while production in the northeast started up only recently in 1983. The majority of known resources and reserves is bituminous coal. 1.5×10^9 tonnes of total reserves are classified as metallurgical coal and 1.2×10^9 tonnes of thermal coal are assessed to exist in B.C. Table 4 shows B.C.'s estimates, coalfields and mining methods. Federal estimates of recoverable reserves are similar to B.C. 'reserves' but B.C. includes more fields and is more generous in tonnage estimates. Reserves represent about two hundred and fifty years supply at current production levels.

Both surface and underground mining techniques are used to extract Western coal. Plains coal occurs in layers and therefore lends itself to surface operations by drag lines whereas subbituminous and bituminous deposits in the foothills and mountains can occur in a convoluted formation due to folding or are too deep for surface mining methods. Capital intensive surface mining allows high rates of output per man. In dragline stripping or 'strip-mining' the coal fields are 'ploughed' with waste material redeposited in the mined-out area. Truck-and-shovel stripping used in open pit mining is more costly. Underground mining includes long wall, room and pillar and hydraulic mining methods and in general is much more labour-intensive and on average is characterized by lower labour productivity. Newer methods are capable of economizing on labour use and have higher productivity. For example, in long wall mining, shearing machines cut the coal from the walls of tunnels up to 3,300 metres in length working up to 215 metres at a time. This technology is not yet used in the West. More traditional room-and-pillar mining is used as well as new hydraulic mining which extracts the coal with jets of water. Coal transport from the mines in this case is by water rather than a more traditional system of rails or conveyor belts.

III AN ACCOUNT OF RECENT COAL PRODUCTION AND SALES

The renewal in Western Coal production came during the 1960s with the commitment to coal-fired thermal electric generation on the Plains and with the new export market in Japan. B.C. did not adopt thermal electricity generation because of its large hydro potential and also because the opportunity cost of using good quality thermal bituminous coal was too great given the potential for high-valued exports. The broad pattern of sales established by Western producers in the early seventies has been maintained until now.

Coal production in Saskatchewan is centred on the lignite coal fields in the south of the province along the U.S. border and the growth of production has been derived from the demand for provincial electricity. (Table 5). Small amounts of electricity are also exported but this is on the basis of a reciprocal agreement with North Dakota which uses Saskatchewan electricity from the Boundary Dam (thermal) station in summer and sends electricity to Saskatchewan in winter. Firm electricity sales have not been the policy in either Saskatchewan or North Dakota. Some coal is exported to Manitoba under a contract which covers "on demand" sales when Manitoba's hydro supply is low due to low water levels. The only firm exports of coal are to Ontario Hydro's plant at Thunder Bay. Saskatchewan coal is provided on a cost basis and from Ontario Hydro's viewpoint, it is high-cost because of rail costs and relatively low energy content. Small amounts also are exported to the U.S. The doubling of sales volume between the early seventies and 1981 is related mainly to the growth in mine-mouth demand for electricity for domestic use. Coal fired thermal generation provides about 75 per cent of Saskatchewan's capacity and hydro provides most of the rest. Further hydro development is unlikely due to higher costs and lack of desirable sites.[10]

The growth in Alberta subbituminous coal production is also tied to domestic thermal generation. In 1963, for example, Alberta used one-fifth of the thermal coal that Ontario used while Alberta now uses about as much as Ontario. Hence, Ontario has quadrupled its use while Alberta use has grown by a factor of twenty-two. This also means that production of the subbituminous coal used for electricity generation has grown by about the same amount. Some bituminous coal also is used for power generation in the province but most is exported either to Ontario for use as thermal coal, to Japan as both thermal and coking coal or a number of other, smaller export markets. Small amounts of subbituminous coal go to Saskatchewan but as with Saskatchewan lignite, higher transportation costs relative to the low energy content by volume mean that these coals are more expensive to importers than alternative sources. As far as thermal coal is concerned, it is the higher valued, high volatile bituminous thermal coal and the coking coal which are mainly exported from Alberta.

In 1982 and 1983, 80% of subbituminous coal came from only two surface mines (Highvale and Whitewood - owned by TransAlta Utilities) and virtually all of the thermal bituminous coal came from surface mines including the new Gregg River Resources Mine. Total coking bituminous coal production was greater than thermal in 1983 and was produced mainly at three surface mines (Cardinal River and Smoky River surface mines, Smoky River underground mine and Gregg River Resources Ltd.'s near surface mine).[11] Of these amounts 99 per cent of subbituminous coal and 7 per cent of clean bituminous were used in the province. About one half of the thermal bituminous coal that left the province also left the country mainly to Japan. Virtually all of the clean metallurgical coal left the country. Of total clean bituminous coal production two thirds was metallurgical in 1983 which is an increased

share mainly due to the new production at Gregg River.[12]

Tables 6, 7 and 8 summarize the main characteristics of Alberta coal markets. Subbituminous coal stays within the province and is relatively low valued on a cost basis. Bituminous coal represents a much higher value of sales (almost 6 times) while volumes sold equal only one-half the subbituminous volumes that are shipped (1981). Japan is the major market for bituminous coals but growth in volumes has not been large since 1970 while shipments to other provinces and other countries have grown. In 1970 Japan took 98 per cent of bituminous sales and in 1983 took 60 per cent. In 1970 1.6 per cent went to other provinces and less than 1 per cent went to other countries while in 1983 these amounts have grown to 20 per cent and 13 per cent respectively.

Small industrial markets also exist domestically for both Alberta and Saskatchewan coal and a very small amount is used residentially. In Saskatchewan, the main non-thermal use is a char plant using coal from the Manitoba and Saskatchewan Coal Company's Bienfait mine.

There are three regions in B.C. which are of current importance for production. The main producing area is the well-established Southeast Region (or East Kootenay) where Westar Resources, Byron Creek Collieries, Crowsnest Resources and Fording Coal all have producing operations. The three coalfields of Flathead, Crowsnest and Elk Valley are centred in the area of the Crowsnest Pass in the extreme southeast corner of the province. Coal was produced in this area in the 1800s and it has been the source of export coal since the 1960s. Both thermal and metallurgical bituminous coal are produced.

The newest producing area is the Northeast British Columbia coal area based on the Peace River coalfield where Quintette Coal and Teck

Corporation have been developing deposits and from which the first shipments were made in December 1983. Some thermal and mainly metallurgical coal will be produced and shipped to Japan. The new developments are centred on the newly established town of Tumbler Ridge and have made necessary the construction of access roads, rail facilities and a new port at Prince Rupert. Given better market conditions a number of other coal deposits exist and could be developed in this region. It has been noted that production from these two projects will represent only 2 per cent of the reserves in the area over a twenty-year period.[13]

The third region is one of potential importance. It is the South-central region which contains the vast Hat Creek coal deposit. B.C. Hydro has studied this region extensively over a number of years as a potential site for either a mine-mouth thermal electricity plant or for a coal conversion plant. Most recent studies have shown that costs are uncompetitive relative to B.C.'s hydro electric costs and demand growth forecasts do not warrant its development. As a feedstock for coal gasification or liquefaction, the lignite and subbituminous coals in the deposit are too costly to convert given current technology and prices of other energy sources with which end products would compete.[14]

Besides these three areas, the Westcoast Region on Vancouver Island may be opened up with the development of the Quinsam Coal Project which would produce at most one million tonnes of thermal coal. Although plans had been made to start construction in 1983, protests on environmental grounds have caused delays.

Shipments of B.C. metallurgical coal to Japan began in 1970 from the special coal port facilities at North Vancouver and Roberts Bank. The large increase in volumes sold between 1969 and 1970 is evident in Table 9.

Tonnes of coal sold tripled in that one year and rose 350 per cent from 1970 to 1980. Average annual percentage growth was 16 per cent over that period but has slowed considerably to a no-growth situation from 1979 to 1982. Prices rose by an average of almost 20 per cent from 1970 to 1980 but recent gains have not been as large and current producers have recently accepted price cuts.

Tables 10 and 11 indicate the dominance of metallurgical coal production in B.C. Although the growth in coal production was the responsibility of the export market for coking coal in Japan, that market has shown no growth in recent years while growth in thermal sales has occurred. Capacity production of metallurgical coal at the new developments in the Northeast coalfield has the potential to almost double metallurgical sales and increase thermal sales by 50 per cent. The recent cutbacks in the amounts purchasers have taken casts some doubt on the ultimate realization of such optimistic growth forecasts without cutbacks of sales by other producers in the West or in other countries.

The distribution of B.C. coal sales has not changed significantly during the 1970s. B.C. is very dependent on Japan and the Pacific Rim countries in general for coal sales. Some sales are made to Ontario Hydro, which has attempted to diversify supply sources even at a greater cost of coal, and these sales have grown during the 1970s.[15] Small amounts are also exported to Europe. Japan dominated in 1982 taking two thirds of B.C. coal sales. This share is down from 1979 when three quarters went to Japan. In 1979, 92 per cent of metallurgical coal sales were destined for the Pacific Rim while 79 per cent of thermal sales stayed in Canada. The data clearly indicate the insignificance of the domestic B.C. market which includes industrial consumers, residential consumers and coke production, and the relatively small

trade with the rest of Canada. No B.C. metallurgical coal reaches the steel-making market in Ontario.

B.C. is much more dependent than Alberta and Saskatchewan on export markets for coal sales because of the small volumes used in B.C. and in the rest of Canada. Of the total amount of bituminous coal exported from the West, B.C. has shipped between 60 per cent and 70 per cent during the 1970s with this share remaining fairly stable throughout. B.C.'s share of the value of total sales typically has been less than the share of volumes. Alberta ships the rest of the Western coal, or about 30 per cent to 40 per cent. As in B.C. most of the shipments are of metallurgical coal but a growing proportion is thermal. Alberta produces more coal than B.C. when both bituminous and subbituminous are counted but total sales value is less. Alberta has produced more coal than B.C. throughout the seventies but the dollar value of coal sales has remained below that received in B.C. throughout the period.

IV ECONOMIC IMPORTANCE OF COAL PRODUCTION

A. Income

Coal is not a large contributor to value-added in the West. Data for the 1970s show that coal value-added has represented less than one per cent of regional Gross Domestic Product for Saskatchewan and Alberta together and has hovered around one per cent in British Columbia since the early 1970s. Coal's share in Canadian Gross Domestic Product is even less, indicating that coal is at least relatively more important to the West as a whole than to the rest of Canada. For comparison, it can be noted that potash value-added in Saskatchewan was 7 per cent of provincial Gross Domestic Product and oil and gas value-added in Saskatchewan alone was 6 per cent (1980). In Alberta oil and gas value-added represented 33 per cent of Gross Domestic Product for 1980.

For Canada, coal's share of mining and milling value-added for all minerals (including oil and gas) peaked in 1975 at 5 per cent but for the most part was about 3 per cent in the seventies. In Saskatchewan and Alberta coal's share has been less than the Canadian average reflecting the relative importance of oil and gas in total mining.[16] British Columbia coal is much more important, contributing up to 35 percent of mining value-added (1975) and averaging 18 per cent since 1970 when coal's share was a mere 1.8 per cent.[17] (Table 12) On a per capita basis coal is clearly a small contributor relative to oil, gas and other minerals but there has been real per capita growth since 1970.

As a contributor to provincial government revenues coal is overshadowed by oil and gas in both Saskatchewan and Alberta and also by potash in Saskatchewan.[18] In Saskatchewan, oil and gas provincial revenues have represented over half of annual total revenues from minerals in the 1970s and

potash revenues have grown to represent about one-third. Coal's share has been less than one per cent.

Petroleum and natural gas revenues completely dominate Alberta's mineral resource revenues contributing 97 per cent of revenues over the period 1973 to 1982. Coal's share is less than one per cent, not even matching revenues obtained from oil sands.

B.C. has a more diversified source of mineral resource revenues. Petroleum and natural gas revenues represent a much smaller share of mineral revenues than in Alberta but the share is similar to that in Saskatchewan. Absolute magnitudes are very different, however, with Alberta oil and gas revenues at almost $4 billion (fiscal 1979), Saskatchewan at almost $400 million (calendar 1979) and B.C. at almost $46 million (calendar 1979). With oil and gas revenues contributing just over half of total mineral revenues in B.C., all other minerals including metallics contribute the rest. Coal royalties derived from Crown lands represent only 5 per cent and total coal revenues from both Crown and freehold represented 15 per cent in 1979. The share has grown since 1974 when it was 6 per cent. Most of the freehold tax revenue comes from coal operations while the balance of all mineral revenues besides oil and gas mainly comes from metallic minerals. Of all western provinces, B.C. has the greatest share of natural resource revenues coming from coal and the absolute magnitudes of revenues are not unlike Alberta. The share has averaged 14 per cent from 1974 to 1982.

If we look at total natural resource revenues rather than just mineral revenue, we find coal revenues represent one percent, or less, of total natural resource revenues and also of total provincial revenues. Saskatchewan and Alberta are much more dependent on mineral revenues as a source of government revenues than B.C. but this is based on oil and gas and

potash and not coal. This dependence has grown in Saskatchewan and Alberta over the 1970s along with the growing importance of oil, gas and potash but again coal has maintained a constant but small share. In B.C. a much smaller proportion of total natural resource revenues comes from minerals with fluctuating forestry revenues dominating.

There is a further public revenue which is not explicitly shown in the discussion of provincial government receipts from the coal industry. It is provincial policy in both Saskatchewan and Alberta to avoid placing a large tax burden on coal which is destined for use in provincial electricity generation. It is for this reason that freehold coal is not taxed in Alberta where all freehold coal is subbituminous coal used domestically.[19] Lower electricity rates presumably are passed onto consumers. In this sense, the lower rates represent a subsidy to consumers which derives from the difference between coal's cost to utilities and its opportunity cost. This implicit subsidy also can be viewed as a public revenue which is derived from coal but bypasses government collection going directly to consumers. The subsidy is also a value which is excluded from the value-added calculations.

The provincial revenues reported above included only those derived from the industries particularly because they are mineral industries. All other revenues which accrue to the province or the federal government through the income tax system or to municipalities through property taxes are not included. These taxes would apply for any industry and therefore are not included here as revenues associated with natural resources.

B. Employment

In the early part of the century coal mining was typically a labour intensive endeavour at many small underground mines. During the 1920s in Alberta, for example, the majority of mines were very small with 293 of

362 mines producing less than 1,000 tonnes each and representing only 5 per cent of Alberta's production. Average mine employment fell dramatically from 1950 to the late 1960s while the number of mines has fallen continuously from the first quarter of the century. Mines are now large, predominately surface mines in which labour productivity has risen almost continuously since 1955. Average employment has risen since the late 1960s with the expansion of production at thermal electricity mine-mouth operations and for export markets.[20]

A similar trend is evident in B.C. where total employment peaked in 1921 and bottomed out in 1967 before it began to climb in association with expanded production for export markets. Employment in 1979 was just over one half of the emplcyment level existing in 1920 and less than the level in 1910 while productivity has grown dramatically over the century. As in Alberta, two main periods are evident. Before 1960 underground mines predominated and output per worker averaged about 500 tonnes per worker per year. In the 1970s output averaged just under 3,000 tonnes per worker at mines which are mainly open pit operations.[21]

During the 1970s the coal industry has represented a greater share of mining industry employment in the West than in the rest of Canada. Tables 15 and 16 show the employment shares of coal industry mining in Canada generally being half the share in the Plains and almost one-third the share in B.C. The dominant position of oil and gas is clear for the Plains as is the growing importance of the coal industry in B.C. Coal's share of employment in B.C. has doubled since 1970 with the expansion of export markets while fairly constant shares in the Plains region suggest that growth has been about the same in both petroleum and coal industries and that these industries have dominated mining industry employment in the provinces. In B.C.,

metal mining employment growth has been fairly flat throughout the seventies leaving the coal industry to provide the growth in total mining industry employment.

The growth in employment levels throughout the seventies reflects the extensive growth of the industry, or in other words, the fact that the industry is now larger. Increases in production have meant more jobs for Westerners. But there has been intensive growth as well in terms of the average value-added growth in the West. Value-added per worker has exceeded the national coal industry average in both the Plains and B.C. since 1971 and has shown the greatest growth in B.C. which has the highest value-added per worker in coal mines. Higher labour productivity and higher prices of coal would contribute to this result. (Table 17)

The percentage share of value-added in coal mining which goes to workers as wages exceeds that in total mining industries in Canada and the West. A survey analysis such as this does not reveal why this could be the case but it could reflect a relatively greater labour intensity in coal over other mining industries, greater ability on the part of coal workers to bargain for higher wages or lower natural resource rents in coal. Higher wages is one explanation that may in fact be true for coal. Also, coal prices in Saskatchewan and Alberta are based on costs of production when the coal is used domestically with the rate of return to capital regulated. Any returns to the resource itself presumably are passed on to electricity consumers. This has the result of underestimating the value-added portion of sales value. Labour's percentage share would be smaller if we could correct for this measurement of coal's value in this region. Labour's share is smaller in B.C. where coal price levels are based on export markets and hence value-added is a better measure of the value of coal production in the province.

C. Prices

The major problem facing the coal industry today is the reality of price cuts and the prospect of further downward revision of coal prices covered under long-term contracts with Japan. The recent oil glut has reduced the substitution value of oil relative to coal in thermal electricity generation. The recent recession has dampened demand for energy, and hence thermal coal, and also for steel, and hence coking coal.

Western Canadian coal producers accepted price cuts of $10 to $12 (about 15 per cent) for coal deliveries starting in April of 1983. Western metallurgical coal prices fell to about $69 per tonne as a result.[22] Contract prices for the new Northeast British Columbia coal on the other hand, have escalated to over $90 per tonne since contract signing in 1980. The opinion has been advanced by more than one observer that the new metallurgical coal producers in Canada are receiving over-inflated prices for their coal. It is the established producers who have accepted the price cuts thus far. The phenomenon is not restricted to Canadian sales. Examples of other recent price cuts include the 15 per cent cut agreed upon by an Australian producer and Japanese steel mills in the last half of 1983 and the 7 per cent cut in December of 1983 by the major American supplier of metallurgical coal to Japan. Over the past two and a half years the downward trend has persisted with metallurgical coal prices falling over the period by an estimated 20 per cent in nominal terms. The trend of downward revision of both volumes and prices continued through 1984.[23]

Along with the price cuts has come a change in expectations bringing downward revisions in virtually all demand forecasts. In the early 1970s the situation was the exact opposite for metallurgical coal. In 1974, the Energy Resources Conservation Board noted that all contract prices had been

renegotiated resulting in prices higher than those initially agreed upon. Over the four years from the initial signing of contracts for most mines, contract prices went up by about $7.00 which represented approximately a 60 per cent increase over four years. In the case of Coleman Collieries Limited the increase was for more than 80 per cent over a six-year period. Reasons cited for the renegotiations included a higher commodity price for metallurgical coal, transportation cost increases, and a correction for the previously underestimated production cost component of the coal.

The increasing unit value of coal and other Western minerals during the 1970s contributed to the increased relative importance of minerals in the West as did the larger volumes produced. The average value of sales is used as an indicator of the rising price of minerals in Tables 18 and 19. The index numbers of both Tables provide a better indication of price increases during the period by showing the changes in price relative to the base year of 1971. For all Western minerals, price increases were greatest for imported oil and for domestic oil but important price gains were made for uranium (419 per cent) and Alberta and B.C. bituminous coal (439 per cent and 333 per cent respectively) from 1972 to 1982. The departure from the low and stable price trend for B.C. coal is evident after 1971 when exports started. The trend is similar for Alberta bituminous coal while price increases for domestically-used subbituminous coal are much lower. Price increases for lignite have been even more modest. Since the thermal coal which is used within the province is priced at cost of production with an allowance for some rate of return to capital, these small price increases reflect the increased cost of production that has occurred for industries in general rather than the increased energy-value of thermal coal. When compared to the price index for coal consumed by all electric utilities in Canada, the price

increases in Saskatchewan and Alberta for thermal coal have been modest in comparison - 30 per cent less in Saskatchewan and 10 per cent less in Alberta. To some extent, however, the differential may be due to the relatively lower energy value of the Western coals used in thermal plants. When compared to internationally traded thermal coal, which has a much higher energy content, price increases for domestically used thermal coal in the West have been even more modest. Internationally traded thermal coal prices rose by 173.5 per cent between 1973 and 1978 while Saskatchewan lignite rose 51 per cent and Alberta subbituminous rose 47 per cent during that time. Internationally traded oil prices rose by 405.6 per cent over the same period.[24] To the extent that Western coal is underpriced according to its energy content and opportunity cost we have undervalued the coal by using an average value of sales to utilities as a proxy for the value. If the benefit of low-cost coal is passed on to electricity consumers through lower electricity rates then this implicit subsidy associated with each tonne of coal used should be added onto the average values of Tables 18 and 19 in order to arrive at a true estimate of the value of thermal coal produced and used in the West.

The price increases in the West's exportable mineral commodities have been important because these increases have been greater than the increased prices of goods imported to the West. As a general indicator of the relative price changes which favoured the West, Table 19 shows the comparison between the price increases of the minerals and the price of manufactured goods. The choice of the manufacturing price index as a basis for comparison of the relative price trends is premised on the fact that the West, on balance, imports more highly processed goods and exports primary goods. An increasing relative price of the goods that the West exports indicates that the purchasing power of the West is increasing in terms of the imports it can

finance with its exports. In other words, increasing relative prices indicates real income gains. Oil has provided the greatest relative gain for the West but bituminous coal prices have experienced gains contributing to real trade improvements in the position of both Alberta and British Columbia over the period 1972 to 1982. It is in comparison to this performance that the slump of the past few years has been so sobering.

V. MARKET STRUCTURE AND THE PROBLEM OF MARKET POWER

Traditional international trade in coal has been for metallurgical coal. While this trade is still important the new international trade in steam coal has shown the most growth recently and is expected to dominate world coal trade by the year 2,000. These shifts have been determined by structural shifts in the demand for these commodities which are expected to be permanent changes. We briefly survey the changes in the foundations of coal demand and extend this discussion by reviewing the patterns of trade for both types of coal and the West's role in this trade. The main points to be noted include the fact that the world trade in coal is regionally determined by the high cost of transportation. This places a restriction on the West's access to World markets. Because of this restriction and the dominance of Japanese demand in both the world market and the West's main market, there is concern that Japan is using, or will use, its dominant position to exercise market power. The implications of transportation cost restrictions and market power for growth in the Alberta and B.C. coal industries are important given the dependence on one market, the large amount of new and committed coal production capacity and the investment of public funds in the country's only recent megaproject which is the new Northeast B.C. coal development.

A. World Resources and Trade

World coal resources are more widely distributed than many other minerals. Table 20 which is from the World Coal Study (1980) indicates this diversity and the production data reflect the same diversity (Table 21). Because of the indigenous coal endowments of major coal users, coal trade has been small and has been dominated by the imports of major industrialized countries which are not so well endowed with coal; Japan, for example.

The top three in terms of reserves maintain their positions in terms of production while Canada, which is tenth in terms of reserves, is not one of the top ten producers. The top four countries represent two thirds of production. As expected, the top five producers are not major importers while lower ranked producers and non-producers do import (Table 22).

Before 1981 Canada was a net importer of coal. The exports of Western coal did not outweigh imported volumes of metallurgical and thermal coal to Ontario until that year. With increased imports of Western coal to Ontario there are expectations that the net export position will be maintained as long as Western export losses are not large.

The U.S., Australia, South Africa and Poland were the world's major exporters of coal in 1982. Canada ranked 6th after Poland and the U.S.S.R. World trade in coal was estimated at 284 million tonnes in 1982 by Chase Econometrics of which the U.S. represented 34 per cent and Canada represented 6 per cent. For thermal coal, the U.S., South Africa, Poland and Australia dominated world trade of about 110 million metric tonnes while Australia, the U.S. and Canada dominate the remainder which was metallurgical coal trade. Canada's share of metallurgical coal trade was about 10 per cent.

It is clear that Japan is the world's major metallurgical coal importer taking 60 per cent of total OECD imports and almost half of all imports. For steam coal, no one country dominates but France does take the most. The OECD as a whole imports three quarters of both coal types.

Japan is a major world steel producer following North America and the U.S.S.R. Western Canada benefitted from the growth in Japanese steel production in the 1970s through Japanese demand for metallurgical coal. Australia and the U.S. have provided most of Japan's imports (between 35 per

cent and 50 per cent together) throughout the seventies while Canada has been the third largest supplier with its share fluctuating annually from 10 per cent to 20 per cent (Table 23). The Australians have recently been supplying about half of Japan's metallurgical coal imports. The Canadian volumes have come from Western Canada and mainly from B.C. The volume of sales from the West doubled from 9 million tonnes in 1972 to 18 million tonnes in 1981 and the value of sales almost doubled over the same period. The B.C. share of annual volumes averaged about 65 per cent and its share of value was about 63 per cent.[25]

The growth of Japanese metallurgical coal demand, throughout the seventies, has been affected by a number of changes in technology and economic parameters which will continue to affect Japanese demand for coal. On the technological side, there have been changes in the ability to substitute between fuel oil injection in blast furnaces and the use of coke in steel making. The cost of coking coal is one of the major costs of steel-making and reductions in the use of this input can moderate overall cost increases. From a coking rate of 619 kg of coke per tonne of hot metal produced in the early seventies efficiencies were achieved which meant that only 426 kg were required in 1978. Higher oil prices after 1978 reversed this trend and the coking rate rose to 485 kg in 1982. This had the beneficial effect for coal exporters of moderating any potential declines in metallurgical coal demand. Reductions in the relative price of fuel oil can reduce coal demand given the enhanced substitutability of these two inputs. Further innovation, however, in the substitution of pulverized coal in fuel injection replacing fuel oil would improve coal demand. But the efforts are only warranted if coal is sufficiently cheap relative to oil.

General efficiency improvements in steel-making which have

increased the yield of rolled steel per unit of crude steel are related to the adoption of continuous casting, rather than ingot-moulding, and improvements in steel rolling. These efficiencies imply a reduction in the need for coal per unit of final product.

Changes in the technique used to make steel from the basic oxygen furnace which uses coke, to the electric arc furnace have taken place in Japan already and further major shifts are not expected. In new steel producing countries, however, if the electric arc furnace is preferred because of its relatively small size and related ease of expansion, then demand for coking coal will not rise to replace reductions in Japanese steel production. This will happen if Japan loses some of its growth potential in steelmaking because of the competition from lower cost new producers in South Korea, Taiwan and South America, for example.

Japanese coking coal demand is being reduced further because of the pressure of substitution of other materials such as plastics in steel's traditional markets. For example, the weight of steel used in U.S. cars was almost halved from 1973 to 1982. This is a factor affecting all steel producers and not just Japan. With the emergence of lower cost producers, there may be a favourable shift in the relative price of steel and this may moderate substitution away from steel. If Japan can match the low prices, through lower production costs, coking coal demand may not suffer. However, moderating costs may also mean reducing the use of coke and/or obtaining cheap coal. Japan's coal suppliers are faced, therefore, with moderated growth in tonnages and prices. Given the excess of supply potential available from its suppliers, Japan has had the potential to reduce both price and tonnages.

Along with the longer-run, structural changes affecting coal demand discussed above, there exist shorter-run pressures which cause fluctua-

tions in values and volumes of coal imports (exports). For instance, steel demand is highly susceptible to changes in economic activity thus suggesting high income elasticity of demand. During recessionary periods such as the one from which we are apparently emerging, steel demand drops and derived coal demand also drops. The recent cutbacks in volumes and prices facing all Japan's supply sources are evidence of this. Volume cutbacks for Japan's suppliers have ranged from 10 per cent to 50 per cent of contracted amounts. The larger cutbacks typically affect short-term contracts while the smaller cutbacks have been applied to the longer-term contracts of new producers. The older, long-term contracts which allow for annual price determination have received volume cutbacks of about 30 per cent.[26]

Although the short-run fluctuations are damaging to the coal suppliers, particularly if chronic over-supply is maintained, the major concern must be with long-run secular changes. Coal producers apparently have accepted the long-run decline of metallurgical coal demand growth rates relative to thermal coal demand. The reaction has been to look to other markets where new steel capacity is being installed. But general factors affecting world-wide steel demand suggest that growth even here will not be great; more or less replacing losses in Japan. Canada has had some recent success, however, in other Pacific Rim markets. Exports in 1981 were greater than in 1980 to both Taiwan and Korea. Exports rose from 1.5 million tonnes valued at $92.4 million in 1980 to 2.0 million tonnes valued at $134.8 million for these markets combined. Volumes shipped to Japan fell by 0.6 million tonnes and $2.9 million over the same period. Increased sales to Korea and Taiwan were of metallurgical coal while the net change in Japanese sales involved reductions in metallurgical sales but increased thermal sales.

The most noticeable reaction by the Canadian industry to expected

slow growth in metallurgical markets is the shift to plans for thermal coal projects. Besides the completion of already committed projects, all other potential operations will extract thermal coal. Other opportunities that have been discussed recently include the marketing of traditional metallurgical grade coals as thermal coals where coal qualities allow this and coal preparation adaptations are feasible.

The growth in steam coal trade is directly related to the oil crisis of the early seventies which stimulated the demand for alternative sources of energy. Coal was recognized not only as a relatively cheaper fuel when compared to oil, but it could be obtained from more diversified sources. Coal was chosen along with uranium as a substitute fuel for electricity generation. Coal has been called the "Bridge to the Future" where the future implies worldwide reliance on as yet commercially unproven energy technologies such as fusion energy. Increased demand for coal raised its relative price and this has stimulated the development of new supply sources. Prices have not risen to an equivalence value with oil. Analysis by the IEA coal research group has shown that at least up until 1980 there was still a price gap which was equal to about 40 percent in the end use of coal on a thermal equivalence basis compared to oil.[27] Given cheap oil due to the recent slowdown in economic activity, conservation gains, and environmental concerns there has been a slowdown in conversions of thermal plants to coal.

Transportation costs are still a large enough percentage of delivered coal prices to limit the geographic scope of trade in thermal coal. Canada's trade has been mainly restricted to the Pacific Rim although some shipments have been made to Europe. The U.S. East coast, Australia, South Africa and Poland are more favourably located to service the European market

ferred quality characteristics such as low sulphur content but it is believed that reliability of Canadian supply and diversification policies of importers have been more important factors determining the exports that have been made to Europe from Canada. Analysis done by the World Coal Study on thermal coal transport costs and delivered prices showed that Western Canadian coal delivered either to Northwest Europe or to Japan has the highest land transport costs to port along with the Western U.S. coal. Marine transport costs are higher than Poland, South Africa and the U.S. for delivery to Europe and higher than Australia for delivery to Japan. The net result of transportation and handling means that the West's coal, along with that of the Western U.S., is more expensive per unit of energy content than all other coals in the European markets. U.S. coal and Western Canadian coals also have been the highest priced in Japanese markets (Table 24). On a per tonne basis Canadian coals are not always the most costly to consuming countries but on an energy content basis, this is usually the case. The main problem is not the unit transport costs per kilometre shipped by rail in Canada, because these are the lowest in the world, but the number of kilometres which must be travelled to tidewater. Once at port, costs become among the lowest because of Western Canada's efficient port facilities for handling coal and marine transport costs are not relatively high, at least for the Japanese market where the efficient Japanese shipping industry is used.

This analysis is based on information available in the late seventies but this remains the general belief in the industry. A more recent analysis as reported in the forthcoming Review of the Alberta Coal Industry indicates that the costs of coal extraction at $6 - $8 in the Plains, $10 - $15 in the Foothills and $15 - $25 in the Mountains. Exportable coal must be cleaned at a cost of between $5 and $7 per tonne of clean coal.[28] Transport-

ation costs can then double the final cost of Alberta coal received by a consumer overseas or in Ontario. Coal from southwest Alberta can cost $25/tonne to transport by rail to Thunder Bay and $18/tonne to the West coast. Transportation costs from northwest Alberta fields is higher at $20 - $30/tonne to both destinations. Other handling costs at terminals and surface treatment to handle dust add to the transportation costs as do the shipping costs. A paper presented to a coal conference in 1983 also confirms these general conclusions concerning current transportation costs (Table 25).

Transportation facilities have expanded in Canada to accommodate the projected growth in metallurgical coal exports from Western Canada. Except for some bottlenecks at a small number of locations in the rail system, no problems are expected as long as revisions to the Crow Rate have been sufficient to provide the necessary funds to rail companies to complete their improvements. The adequacy of the coal port facilities can be illustrated by the major expansions currently taking place on the West Coast. Roberts Bank (Vancouver) has recently doubled capacity to about 24 million tonnes/year with the possibility of further expansion to 30 million tonnes and an ultimate doubling of capacity to 60 million tonnes/year. The other major development is the Ridley Island terminal which is adding a further 13 million tonnes/year capacity for use by the Northeast coal developments as well as other bulk commodity exports such as grain and potash. Although these expansions have been planned with coking coal export expansion mainly in mind, the facilities will of course be perfectly adaptable to the thermal exports which are expected to grow in place of major metallurgical coal exports.

B. The Problem of Market Power

The problems in the export market for coal can be viewed from two perspectives. First of all, the industry expanded on the basis of forecasts

of much greater demand than has in fact materialized. The specifics are given elsewhere in this paper but we should note at this point that the result of the overbuilding in Canada and abroad is lower prices and therefore the inability to cover average total costs in some cases and possible shutdown. This situation is possible in any industry where long time lags exist for establishing new supply sources. Forecasting demand conditions is unavoidably risky.

Taking a second perspective we can look at the poor price performance of coal from the point of view of price determination in the industry's particular market structure. We have noted already that the market is geographically determined by the high cost of transportation and within the market area of the Pacific Rim there are many suppliers and few consumers. Japan alone took 60 percent of total OECD metallurgical coal imports in 1982 and this country represents the dominant market for both B.C. and Alberta. As the main industrialized nation without significant indigenous coal reserves Japan is also the main thermal coal market in this area.

When a market has these characteristics price cannot be expected to be determined by the impersonal demand and supply intentions of many independent economic agents. Hence, this is not the case of perfect competition where each independent agent regards himself, and actually is, too small to have a significant impact on the market outcome. Instead, the actions of individual agents have a perceptible effect on the market. Since market demand is concentrated consumers realize that their actions can either improve or harm their profit position. It is reasonable to presume that they do, in fact, realize this and it is also reasonable to assume that this knowledge is not ignored when decisions are made. The position of the Japanese government is clear with its recommendation that bargaining for coal purchases should be done by a unified industry and that imports should be orderly so as to pre-

vent speculation and price fluctuations.[29] Both of these recommendations indicate that there is knowledge of market power and an intention to manage the market.

When demand-side market power is successfully exercised there can be efficiency losses and income redistribution from suppliers to consumers. Very simple models can illustrate these results. We will use three cases to show a range of possibilities. The first is an extreme case where demandside market power is unsuccessful in transferring income or creating inefficiency losses. The second shows an alternative extreme case where income redistribution is maximized while efficiency losses are zero. The third, intermediate case, is more feasible in reality and shows efficiency losses and income redistribution. In all cases we assume for simplicity that there is only one consumer and many producers. The consumer is assumed to be a perfect competitor in his output market.

For the first case the single buyer cannot exploit the suppliers of an input because he is powerless in setting market price. This is the situation when incremental units of the input are available at constant cost. In Diagram I the consumer determines the optimal amount of the input to use by equating the value of the marginal product of the input to him (VMP), to the marginal factor cost (MFC), which in this case is constant and equivalent to supply.[30] The result of Q_1 is efficient and no income redistribution occurs. When dealing with a factor which is an exhaustible resource, however, we would not expect supply to be flat over a large range of output levels. This is because we would not expect individual mines to have the same costs especially considering the range of geological circumstances across countries. The geographical distribution of suppliers alone will lead to locational rents being earned by those suppliers who are close to markets and hence an upward sloping supply curve would exist from the point of view of

Diagram I

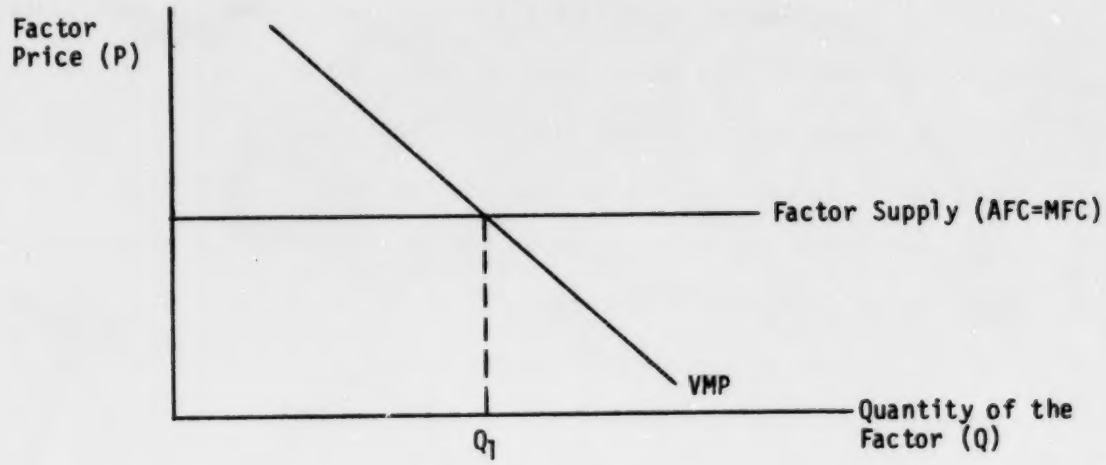


Diagram II

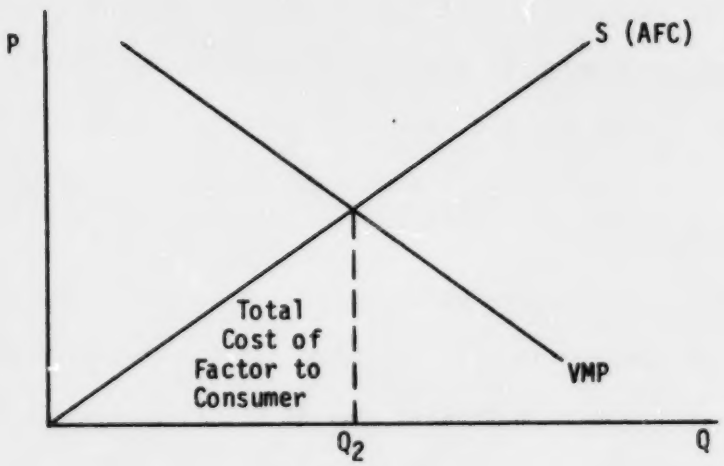
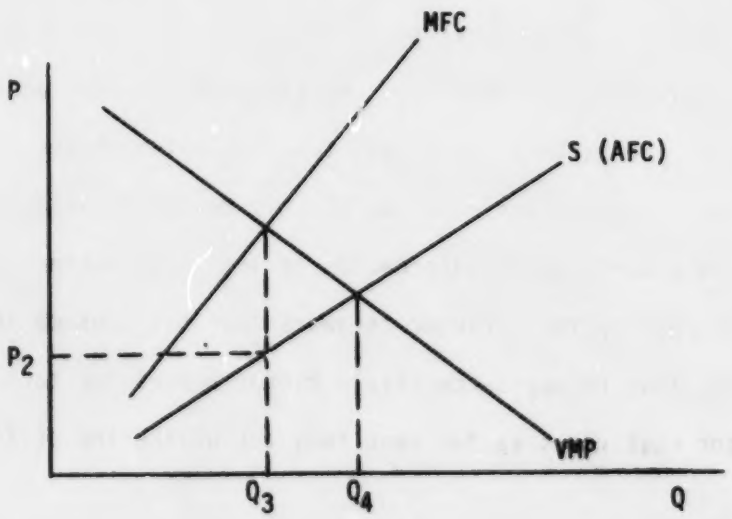


Diagram III



the landed cost of the input in the consuming country. Also, the theory of natural resources tells us that the lowest cost deposits of a resource are exploited first leaving more costly and more remote ones for the future. Depletion leads to a leftward shift of supply curves suggesting that in the long run supply must be upward sloping. Theory also tells us that in the short run it is not costless to expand output because otherwise, it would have been optimal to build a mine in the first place which would have been large enough to extract all of the mineral in one period. Even if there are flat portions of an individual producer's supply curve, the aggregation of different cost suppliers would result in a stepped function which would approximate an upward slope.

When supply is upward sloping and one price is established in the market then only the marginal supplier receives payment exactly equal to the marginal cost of supplying the input. All other, intermarginal producers receive rent. This Ricardian rent arises due to the lower marginal costs of these producers.

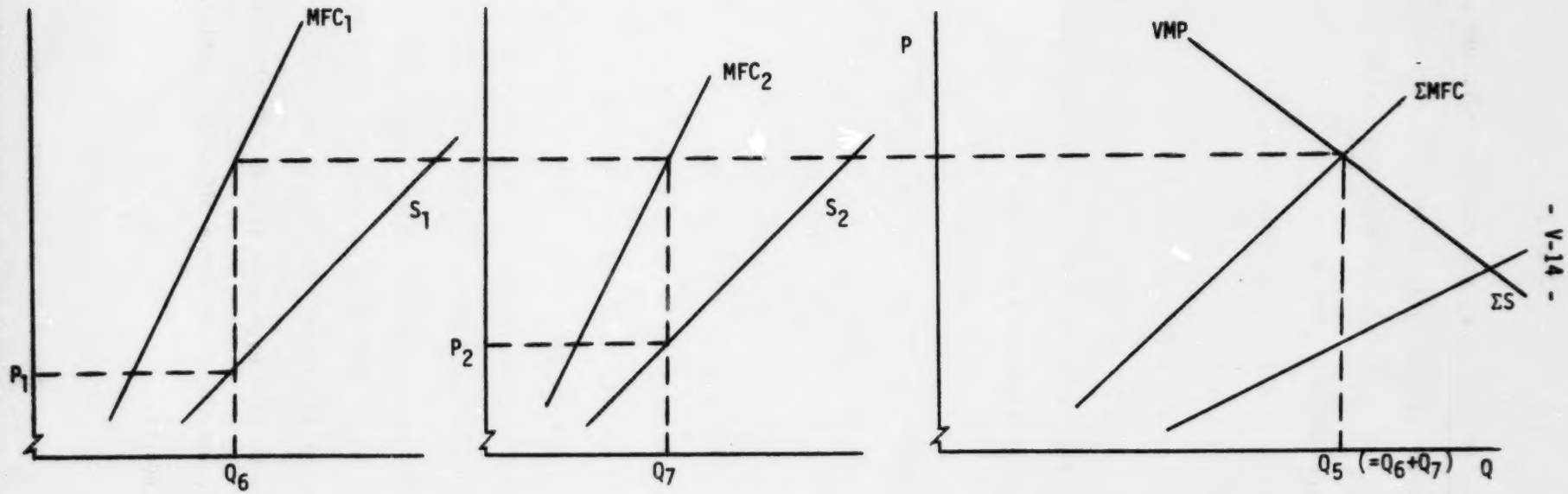
In the second case which we call an extreme case, supply is upward sloping and the consumer has the knowledge and the necessary power to set a different price for each successive unit of the input that it desires. In Diagram II he will buy Q_2 where VMP equals supply. This is an efficient outcome but by paying a price equal to marginal cost for each unit he buys he succeeds in exploiting the resource. He captures all rent and pays all but the supplier of the marginal unit less than the value of the input's marginal product in use. Price discrimination of this degree is illustrative but it is unlikely in a world where information is less than perfect.

In reality the consumer is aware that his consumption of more units requires that he pay successively higher prices for each extra unit. Average factor cost rises as for case two, but unlike the perfectly price

discriminating buyer of that case, the consumer must now pay more for each of the units he is already consuming as he increases his use and therefore the marginal factor cost (MFC), is greater than the average cost. For case three, therefore, the optimal usage of the input exists where MFC equals VMP at Q_3 in Diagram III. This is inefficient since Q is not produced and sold up to the point where AFC=VMP. This situation is also exploitive since the factor receives only p_2 while the value of the factor lies above. The exploitation can be thought of as the difference between what the factors receive, p_2, and what they would receive under the efficient outcome with Q_4. The resource is underpaid and underutilized. The consumer gains when he receives a value of the factor in use which is greater than what he has to pay.

The consumer can increase profits even more if there is an opportunity to discriminate among suppliers in terms of input price. This is possible if his information is good and if his suppliers are effectively separate as they are for coal where transport costs are so high. Diagram IV shows that he can maximize profit if he equates total marginal factor cost to VMP to determine his optimal total purchase (Q_5) and then equate that level of MFC in all supply markets to determine how much to buy from each. He then can pay the lowest price in each market based on the supply conditions in each market. Where supply is least elastic, price will be lowest and where it is most elastic the highest price will be paid. As a result, exploitation increases as low cost producers have some of their rents taken away. Output is the same as the simple case three outcome but costs to the consumer are lower and hence profit is higher. The degree of inefficiency is the same but with discrimination we have even more income redistribution from producer to consumer. The only one who is no worse off with discrimination in case three is the marginal producer.

Diagram IV



C. Dealing with Market Power

The information we have does not allow us to say exactly which market structure is closest to the coal market in the Pacific Rim for two reasons. Firstly, supply information is insufficient for constructing a supply function for coal. This means we cannot show direct evidence of an upward sloping supply curve. Secondly, because of the heterogeneity of coal it is difficult to compare prices to see if there is discrimination. What we do have is circumstantial evidence. For instance, we do know that suppliers have been suffering differential price cuts during the past recession. This suggests that there is at least some degree of price-setting power on the demand side. Since the cuts vary according to supply-source it appears that cost varies according to deposits and that price is being set in relation to cost of production of the coal. The interest expressed by consuming nations in direct investment in joint ventures also provides us with further evidence of the desire to set prices. It should be recalled that one major obstacle to price discrimination is a lack of cost information but this deficiency would be remedied with joint interests.

Prevention of exploitation and elimination of any existing exploitation require drastic measures. Individual producers have little power to prevent income redistribution to consumers and can, in fact be hurt by the expansions of other producers. This suggests that any remedies must be devised and administered collectively either by producers or governments. Here we review the solutions advanced in trade journals and by government officials in conversations we have had with them. To these solutions we have added a further possibility of an optimal tax.

It may be the case that coal exporters can do nothing to prevent the redistribution of income to a powerful consumer but few in the West have despaired to this degree. Instead possible solutions are suggested and the

most often touted of these is the diversification of the West's markets. This would reduce concentration of demand for Canada at least. The fringe of other consumers would limit the price-setting power of the main consumer. There is the problem though of the fringe taking advantage of the low prices and not challenging with higher price offers.

In the past the industry has attempted to ensure reasonable prices by negotiating contracts with buyers. Unfortunately, these contracts include price-renegotiation clauses which have meant that lower prices have been imposed on suppliers recently. When one party in negotiation has little power, it is not surprising that it will not benefit to the extent of the other party. In some cases the consumer has simply failed to take negotiated tonnages and suppliers have little recourse. Diversified markets, as suggested above, would help remedy this situation.

Another way of combatting losses to consumers is the establishment of price controls on Canadian coal exports. This mechanism could prevent subsequent downward revision of coal prices, however, without control over further coal development there is little that can be done to prevent large-scale losses in the volume of coal sales. These losses are likely because of price competition from other domestic and foreign producers. If consumers find it desirable to continue to diversify their supply sources for their own protection and advantage Canada would probably continue to maintain some of the market share but price restrictions on Canadian coal would definitely reduce the benefits of consuming the West's coal.

The most obvious response to consumer power is a producer cartel. This is the standard sort of bilateral monopoly situation where consumer power is balanced by greater producer power in this case. The pooling of supply and price information and price setting would be one way to exert some

supply-side power and counter balance the consumer power. There are many problems with this approach however and these range from the problems of coordinating many diverse international interests, preventing cheating and establishing the sort of international body which has a bad reputation from the beginning. These problems are all significant considering the number of countries which must participate and their very different ideologies. (The U.S., China and South Africa are only three examples of this diversity.) There is also the potential of large, low cost development by lesser developed countries which may not find it beneficial to join. Their entry into the market, without participation in the cartel, would erode the cartel's power. The West is in a particularly difficult position with respect to a coal cartel because of its international position as a relatively high-cost producer. If the West is the marginal producer then an effective international unified supply front may mean higher prices for coal from other countries and less coal sold by Western Canada. While others may regain some real value of production, the West may be the loser. This possibility suggests that the West may not benefit from the formation of an international producer group but if other suppliers do form a group then Canada must participate or risk losing out completely to this more powerful, unified supply front.

The final remedy that we consider here is an optimal tax or subsidy program for coal. There are two branches of recent research that can be applied to coal. First of all, the problem of income redistribution from oil consuming countries to OPEC has stimulated interest in finding ways of preventing these income transfers through an optimal tax on domestic consumers. Secondly, the problem of international competition for new lucrative markets has lead to interest in export subsidies.[31] The first, which is a monopoly problem, can be applied to a monopsony situation where suppliers might at-

tempt to extract monopsony rents through a tax and the second can be thought of as an alternative to direct cooperation among suppliers in the face of demand-side power.

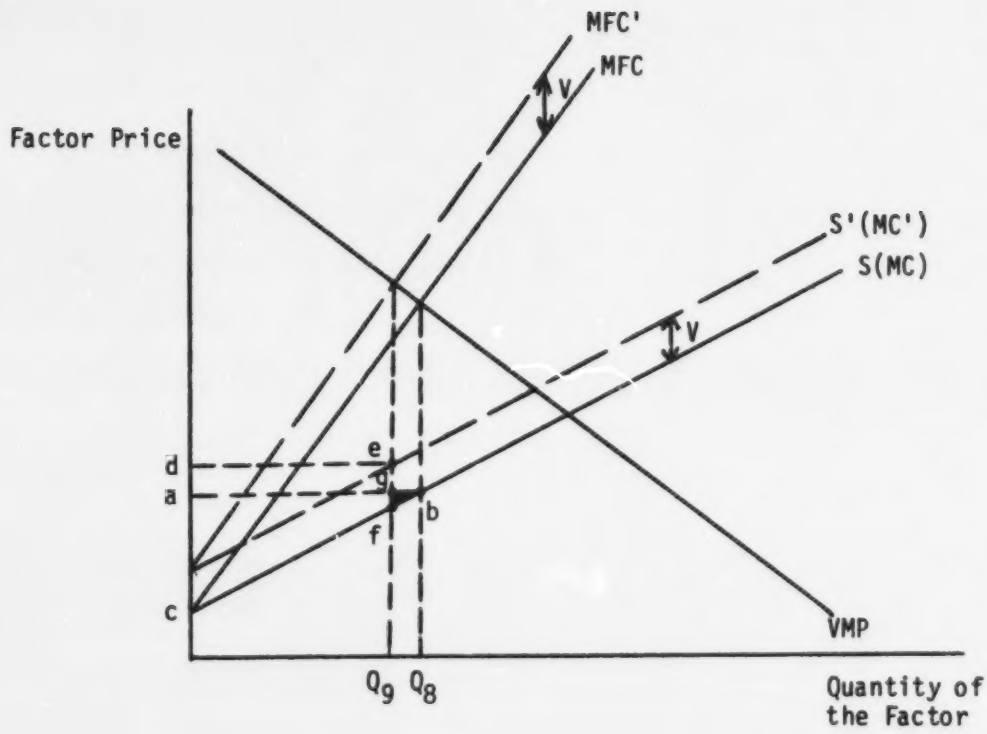
The subsidy approach to export promotion already has been adopted for the exporting coal industry in Canada. Examples include public provision of social overhead capital dedicated to coal developments, public collection and dissemination of market intelligence and public research and demonstration expenditures. It is not at all clear that the subsidy solution is best because of the lack of competition on the demand-side. The optimality of subsidies in part depends on the assumption of perfect competition on the demand side. Without this in reality the possibility is clear that the producer subsidy can become a consumer subsidy with no gain to producers.

The optimal tax idea can be applied to our problem with a simple model similar to those illustrated earlier in diagrams. Our question is whether the coal seller can extract the monopsonist's rents by setting an optimal tax on coal. The goal of the tax would be the recapture of income that would have been redistributed from seller to consumer because of buyer power. Where individual producers are ineffective in preventing income transfers it may be necessary to capture them through the tax before they leave the country. In Diagram V we have the simple monopsony situation depicted earlier in Diagram III. The resource is exploited and receives a price less than its value in use. (If the consumer is at least partially discriminating among suppliers then some of the resource's Ricardian rents of abc also are captured by the consumer. If not, the supplier retains rents totalling the area abc.) Consider now the imposition of a simple, constant per unit tax of v on the coal which shifts up the marginal cost and MFC by an amount v. The consumer adapts to the new MFC' and demands Q_g at a price d.

The supplying country produces less but retained rents are now larger and equal to the area defc. In comparison with the pretax situation the net gain in rents is the area dega, which is the gain, less the loss of gbf.

Diagram V illustrates the gains possible from imposing a tax but with the simple linear model we cannot tell the whole story. In the Appendix we show the general result for an optimal tax. We find that either a tax or a subsidy may be optimal and this depends on the response of the monopsonist to the change. If the monopsonist were to increase price in response to an increase in tax then the results of Diagram V hold and an optimal tax should be imposed. If the response to the tax would be a lower price then a subsidy, or lower tax, would be optimal. We show that the result depends on the actual characteristics of demand and supply. Without empirical work including the specification of the production functions for coal and for steel we cannot say whether a tax or a subsidy is optimal.

Diagram V


MFC'
MFC
V
Factor Price
S'(MC')
S(MC)
V
d
e
g
a
b
f
c
VMP
Q_9 Q_8
Quantity of
the Factor

VI COAL PRICE AND DEMAND DEVELOPMENTS

The forecasts of demand for both thermal and metallurgical coal have been revised downwards annually for the past few years. This reflects the effects of depressed oil prices, the world-wide recession and possibly, market power as well. As is common for forecasts made for commodities which follow cyclical trends, today's forecasts tend to be projections based more on the trough in the cycle while yesterday's were extrapolations of the peak. These effects are evident in both domestic demand for thermal coal and export demand for coal throughout the world. Metallurgical coal demand forecasts also are pessimistic because of the growing opinion that there are long-run structural changes still to be made in the demand for steel and in the technology used for producing a growing percentage of world steel output. For thermal coal, there is still optimism based on expected oil price increases which will raise the demand for coal but this optimism now relates to a time much further into the future. We have already documented the past growth in coal production, employment, value-added, and prices, and the importance of export demand in this growth. In this section we review the forecasts of export and domestic demand for the West's coal and the reasons why no real increase, and probably real declines, in coal prices are expected.

Export demand forecasts for coal are typically based on consuming country forecasts of their own demand. For the West, most of the attention is on the Japanese market for both metallurgical and thermal coal since Japan is expected to remain the most important single market. The forecasts are mainly based on a share analysis which predicts Canada's share of the Japanese import market to either remain at some average of its historical share of between 10 per cent and 25 per cent during the 1970s, or to increase to about 30 per cent on the basis of the apparent policy of the Japanese to diversify

supply sources. The new thermal market forecasts include a more diverse set of markets but they also are based largely on the forecasted demand of Japanese electricity utilities and cement plants and their respective import policies.

Forecasts from a variety of sources are given in Table 26 and summarized in Table 27. These are taken from a three-year period in order to catch the effects of forecasting from the peaks and troughs of economic activity at the time of each forecast. The ranges reflect the expectation that Japan will remain the main customer for both metallurgical and thermal coal and that total coal exports will double from 1982 to 1985 but remain fairly stable until the turn of the century. The significant growth forecast to occur by 1985 is partly influenced by the new production capacity which has recently been completed or will be completed by that time. The forecasts include the contracted volumes from these new projects in the total export demand and Japanese demand even though it is unlikely that these full volumes will be taken. Capacity utilization was about 65 per cent in 1982 due to cutbacks in volumes taken. Table 28 shows that expansions will almost triple thermal capacity by 1985 and metallurgical capacity will rise by over 50 per cent. This suggests two things - installed capacity will more than satisfy all but the most optimistic forecasts of export demand at least until the 1990s and that the industry perceives the major growth to be in thermal exports. Supply is clearly no foreseeable constraint in the West. Also, a number of further projects are feasible given better markets.

The excess supply situation in Canada is reflected in the rest of the world suggesting that upward pressure on coal prices due to supply constraints would be unlikely. Given the demand projections, the outlook for price suggests no real increases are likely. If lower cost producers find it

to their advantage to cut prices, real price declines are a possibility. This would hurt the exports of higher cost suppliers such as those in Canada but it is likely that the consuming-country policies of maintaining diversity of supply and purchasing from reliable countries will prevail and contribute to Canada's maintenance of a share of the market.

Some possible constraints facing coal suppliers include the concern in Japan that the environmental pollution costs of further coal-fired electricity plants are too great and that the relatively higher cost nuclear or liquified natural gas choices should be expanded. There is also concern that China will emerge as a major source of world, and particularly Japanese, coal imports if it can solve its infrastructure problems. Japan is investigating direct investment options in China. Expansion plans in Columbia suggest that further competition is inevitable. Policies in other countries which promote high cost coal production for employment and income reasons restrict markets (U.K. and F.R. Germany). These coal supply and demand policies in other countries are typically nationally coordinated ones where the welfare of the whole country is considered when planning is done. Western producers may have the support of the provinces but a federal coal policy does not exist which protects the industry by either encouraging or stemming activity in the interests of the nation. In some cases, overall Canadian policies may be contrary to the needs of the West. Restrictions on Japanese vehicle imports and steel import restrictions are often-cited examples of policies which hurt coal exports by reducing steel production in Japan and damaging the general negotiation environment. In some other countries, national policies which hurt coal are not adopted because the coal industry is relatively more important as in South Africa. For Canada, coal export trade may be important provincially as in B.C. but not nationally, where high coal

prices (and low exchange rates) mean higher costs for consumers in other parts of the country. In light of the unified national front of coal purchasers and the relatively small size of producer-exporters in the Canadian provinces, these producers seem to be losing bargaining power. The result is possible real income transfers out of the provinces and also, out of Canada as discussed in Section V.

Domestically, Alberta will continue to expand its use of coal-fired electricity generation as will Saskatchewan. Growth is dependent on electricity demand growth which is estimated by the utilities in both provinces. There have been a number of downward revisions in recent years because of the revisions of economic growth forecasts in the provinces.

In Alberta the ERCB has estimated an average annual growth in coal demand for electricity generation of 2.8 percent taking demand from 13 million tonnes in 1982 to 22 million in 1990 and 25.1 million in 2005. Small increases are expected in industrial demand after 1990 in the cement and pulp and paper industries of less than 1 million tonnes. This growth is based on replacing natural gas use with coal. The August 1984 forecasts of electricity demand made by the Electric Utilities Planning Council (EUPC) in Alberta suggests that coal use will be less than projected by the ERCB for 2005. Exports to other provinces are expected to be maintained but transportation costs will likely remain the major impediment to trade within Canada as long as coal from the U.S. flows freely and is relatively cheaper. Stricter environmental controls may, however, make the lower sulphur Western coals more attractive.

In Saskatchewan no major growth is expected since electricity growth forecasts have been revised downwards from 8 per cent annual growth to 3 per cent annual growth (1983 base year). The extra required coal is avail-

able from existing plants for some time given that growth rate. The planned opening of a new Hydro plant at Nipawin in 1986 precludes the need for a new coal-fired plant until the 1990s. When a new plant is needed there may be problems finding a site which is both close to the coal and also a water source sufficiently large to be a good coolant. Trucking of coal or adoption of a gas-cooled plant may be the more costly solutions. Expanded use of coal in the industrial market appears to be contrary to the stated provincial policy of expanding the use of natural gas. Saskatchewan's extensive reserves of natural gas are shut-in because Saskatchewan is locked into contracted purchases of Alberta gas and this has led to the adoption of policies which allow for more domestic use of natural gas so that more of the cheaper domestic supplies can be used.

Prices for coal used in Alberta and Saskatchewan are not expected to increase much more than 1 per cent above general inflation. Selling values are based on cost of production for both domestic sales and exports to Manitoba and Ontario and therefore these values are expected to increase along with construction, or capital costs and the cost of electricity (since draglines run on electricity). These costs are expected to rise at a rate slightly above general inflation and hence the price of coal may rise relative to general inflation but not relative to costs of production.[32]

Other uses of coal such as liquefaction or gasification are not expected to be commercial options in this century in the West mainly due to the abundance of natural gas and tar sands which are lower cost fuels to develop and are also abundant.[33]

VII CONCLUSIONS

Our review has indicated that coal has not been a major contributor to real income growth in the West. The prospects for future income growth are modest mainly because of the pessimistic outlook for future real price increases for coal. While it is unlikely that coal will be the new 'engine of growth' for the West's economy in the foreseeable future there are a number of areas where the contribution of coal could be improved. Our discussion has emphasized real price effects and we have identified two main types of changes that could be made. The first set of changes applies to exported coal and the second applies to coal used domestically. Real income transfers out of the country through price cuts on exportable coal reduce coal's domestic contribution. Minimization of these transfers through alternative resource management policies should be explored. Secondly, there should be an attempt to price coal used domestically at its true value, or opportunity cost, in production and use so that it can be allocated efficiently among its various uses over time. More efficient allocation of resources would contribute to greater income generation as all resources could be directed to their most productive uses.[34]

We have not emphasized the other two prerequisites to growth which were identified in the introduction to this paper. Briefly, we can note that improvements in technology are difficult to protect for Canada's benefit alone since our trading partners can often copy our advances and therefore also gain. Technological innovations which are tailor-made for the West would be best for increasing income relative to the rest of the world. The final prerequisite to growth which calls for identification of a greater resource base is already a reality in the West and is not considered a constraint.

While there are many other aspects of mineral industries that

could be addressed in a review of policy issues, we are most concerned with those that can have direct impact on real income generated in the foreseeable future. For example, while energy policy and possible future export constraints on coal for security of domestic energy supply reasons may be important constraints, these are not of concern to us here because reserves and supply potentials are excessive. Manpower training and environmental issues pose very important problems in some situations, but again proper management of resources and adequate environmental protection should be possible. We also do not address revenue-sharing questions mainly because government revenues from coal are so small now and will likely remain so.

The market structure of the coal industry provides our main area of concern. The simple rules of supply and demand tell us that attempts to increase the real value of production of coal via the expansion of supply sources will be frustrated. Under static market conditions, added supply will lead to lower world prices of all quantities sold. The problem in the West is not availability of supply but management of the resources in light of market conditions and with recognition of price effects of different paths of behavior. Besides the simple impact on price due to supply expansion, the West faces concentration on the demand side of the market. If the West continues along its projected path, market-power will remain vested predominantly in the major export market - Japan. Market growth in Japan is expected but as the August 1983 federal trade policy document also noted, Japanese markets for our goods continue to remain relatively more important to Canadians than Canadian markets are to the Japanese. The West's overdependence on one market leaves it vulnerable to real income losses through potential price and volume cutbacks. When supply is characterized by a large number of unco-ordinated firms competing for sales as it is in the international market

for coal, the major buyer has the potential to pay less than the coal's value in use. Increased competition on the supply-side resulting from more market entry only enhances this effect. While demand is growing this power may not be as obvious while real price grows but during slumps, excess capacity and price cuts raise concern over the use of market power. Because expansion decisions in one province affect the potential future returns in another province we see a federal role in the co-ordination of incremental coal supply. Industry support should be forthcoming since the future returns to their operations depend on the unregulated activities of future entrants.[35]

There is little that coal producers can do to change the main characteristics of the market they face given the smaller size of markets in other Pacific Rim countries, the lower cost competitors in Australia and South Africa and the market barrier imposed by sheer distance to other markets. Although further concentration of power on either side of the market is generally an unfavourable prospect at a time when the desired movement is to freer, more competitive international trade, it may be that the only effective solution to combating the potential price losses imposed by powerful buyers is a reciprocal unified supply front. Existing producers in the West may find that it is to their mutual advantage to share information and coordinate their actions to prevent further losses. A government role is indicated here for both the provinces, as owners of the resource and the federal government in its control over international trade.

The West is in a difficult position, however, because of its international position as a relatively high-cost producer. If the West is the marginal producer then even if an effective international unified supply front could be established this could mean higher prices for coal from other countries and less coal sold by Western Canada. While others may regain some

real value of production, the West may be the loser. This possibility suggests that the West may not benefit from the formation of an international producer group but if other suppliers do form a group then Canada must participate or risk losing out to this more powerful, unified supply front.

As part of their economic development and diversification policies the B.C. and Alberta governments have aggressively pursued foreign direct investment in the coal industry. While providing the injection of needed capital it has also been the belief that direct investment by consuming countries would protect the profitability of the projects. If slumps were to occur it has been presumed that consumers which are also investors would impose smaller price and quantity cuts. However, it is important to note that investors in their dual role as consumers also have an incentive to obtain the cheapest inputs. When they possess two ways to obtain a return on two investments - a return on coal production plus profits on steel sales, for example - while Western mine investors have but one way to maximize their return - profits on coal - the foreign investor is relatively better able to minimize losses. Weighing the costs and benefits of foreign direct investment is the job of the Foreign Investment Review Agency (FIRA) and therefore it is necessary that FIRA should not only recognize the benefits of provincial diversification policies in its decisions but also consider the potential for foreign investors to practice policies which transfer income out of the country. This should be one of the costs evaluated in the general calculation of the net benefit to Canada when investment applications are made. The liberalized attitude toward foreign investment in Canada recently adopted by the new federal government reduces the possibility of using FIRA to prevent income losses.

The possibility of transferring income out of the country draws

attention to the provision of infrastructure by the federal and provincial governments. The federal position is to subsidize these investment costs where the new facilities such as railways or ports will benefit many industries and confidence in future use exists. In this way future rate payments will contribute to the financing. Infrastructure which is dedicated to one industry or one resource is not financed 'up-front'. Alberta has taken this position also but B.C. has not and therefore may bear net losses if further coal develoments do not materialize in this decade and if coal prices are not adequate.[36] If costs are not recouped by the public sector then a subsidy implicitly goes to Canadian export markets. Given the tax/subsidy analysis of Part V it may also be the case that the subsidy is the best option but this should be verified before the policy is used.

The second set of policy issues refers to the opportunities to improve the efficiency of resource use in the coal industry. Improved efficiency should in turn lead to an improved income outlook even if the marketing recommendations are not followed. We have concentrated on taxes and domestic pricing policies.

The structure of the resource taxation can at times impose excess burdens on the industry. For example, the resource taxes calculated as a percentage of revenue may mean taxes are payable even if no profits are earned. Such a tax also has the potential to distort the extraction plans of mine owners. As a result, the tax system itself can lead to altered rates of extraction, exploration effort, cut-off grades and mine lives. This sort of tax applies to coal operations in both B.C. and Alberta. A tax based on profits may have the potential to reduce these distortions.

In B.C. there have been attempts to impose a profits tax on mining firms and this applies to coal operations in addition to the specific coal

tax. It has been ineffective in raising revenues regardless of profitability of individual mines. This is because mining firms calculate tax based on the net income from all operations with cost deductions allowed for exploration and development expenditures made anywhere in the whole province. Profits generated at a particularly lucrative operation can be offset by expenditures on a new venture. This is one example of why profits taxes can be very difficult to design and implement but regardless of the difficulty in designing an effective profits tax system it is important that there be an effort to design royalty systems which are designed so as to be as undistortionary as possible. This calls for some sort of profits-based tax.

Distortions also exist in the domestic pricing of coal. It has been the practice in the West to price coal and natural gas, in particular, at prices below those in the rest of Canada or the world when the minerals are used domestically. This means that domestic consumers are subsidized in the West since the coal that is consumed at power plants is priced at cost rather than at some value based on its price in its alternative use where some return in excess of cost might be obtained. This might entail export to another province or the U.S. now or in the future or the conversion of coal into a high valued alternative form such as a liquid. Transportation costs currently raise the price of the coal too much to make it competitive on a delivered price basis but in the future this may change as thermal coal's value rises with the price of its alternative - oil. When coal is not valued at its value in its next best use when thermal electricity plant expansions are evaluated coal may not be directed to the most profitable market. Very low cost coal receives no extra return relative to higher cost coal and this affects producer incentives. The extra return is passed on to consumers. The extent of the subsidy going to electricity consumers is unknown when coal

is simply valued at cost. This means that the value of coal production in Alberta and Saskatchewan is undervalued to some extent. Coal's true value is underestimated by the amount of the implicit subsidy (which is unknown) and better alternatives to coal's use as a fuel for thermal electricity generation may be overlooked if coal is valued at cost.

Although current markets are depressed, and economic coal reserves are extensive it is recommended that coal not be undervalued when it is used domestically or if it is a policy decision to do so, the value of this subsidy should be evaluated by determining the value of the coal according to its value in its next best use. This practice will ensure that when investment decisions are made, coal will be used in the most valuable way possible and producer and consumer incentives will not be distorted. Since we do not know the extent of the distortion we cannot make a detailed suggestion but we do suggest that this problem should be studied in detail by the provincial authorities so that coal's opportunity cost can be evaluated.

The above policies deal with the opportunity to improve income gains in the case of coal where the West's consumers have power and where current institutional practices may be inefficient. These policies address improvements in the price of minerals - the first prerequisite to growth and the one which this paper has emphasized.

Tables
and
Figures

TABLE 1

Inter-relations of Rank, Quality and Use

Coal of this rank		Generally has these qualities	and has these potential uses or these characteristics	Depending on qualities such as:
Class	Group			
Anthracitic	All groups	Relatively high calorific value	As a thermal coal	Quantity of ash, sulphur and other deleterious constituent and the extent to which they can be removed or suitably reduced by beneficiation processes; ash fusibility
		Non-agglomerating	Does not coke	
		Low moisture content	Stores and transports well	
		High fixed carbon content	Source of carbon	
Bituminous	All groups	Variably agglomerating	As a blend or directly for making metallurgical coke	Sulphur content and extent to which it can be removed or reduced by beneficiation processes; coal type
		Relatively high calorific value	As a thermal coal	Comments at top of column apply here as well
		Low moisture content	Stores and transports well	
	Hv A, B and C	Fairly high volatile matter content	For gasification or liquefaction	
Sub-bituminous	All groups	Non-agglomerating	Does not coke	
		Moderately high calorific value	As a mine-site thermal coal	Comments at top of column apply here as well
		High moisture content	Does not store or transport well; subject to spontaneous combustion	
		High volatile matter content	For gasification or liquefaction	
Lignitic	All groups	Non-agglomerating	Does not coke	
		Relatively low calorific value	As a mine-site thermal coal	Comments at top of column apply here as well
		High moisture content	Does not store or transport well; subject to spontaneous combustion; may necessitate drying before use	

Source: Energy, Mines and Resources Canada, (EMR), Coal Resources and Reserves of Canada, Report ER 79-9

FIGURE 1

Summarized Classification of Coal by Rank

VM%*	FC%*	CLASS	GROUP	CALORIFIC VALUE**	
				Btu per lb	MJ/kg
		ANTHRACITIC (1)	META — ANTHRACITE		
2	98		ANTHRACITE		
8	92		SEMIANTHRACITE		
14	86	BITUMINOUS (2)	LOW VOLATILE BITUMINOUS		
22	78		MEDIUM VOLATILE BITUMINOUS		
31	69		HIGH VOLATILE A BITUMINOUS	14 000	32 6
			HIGH VOLATILE B BITUMINOUS	13 000	30 2
			HIGH VOLATILE C BITUMINOUS	11 500	26 7
		SUBBITUMINOUS (4)	SUBBITUMINOUS A (3)	10 500	24 4
			SUBBITUMINOUS B	9 500	22 1
			SUBBITUMINOUS C	8 300	19 3
		LIGNITIC (4)	LIGNITE A	6 300	14 7
			LIGNITE B		

* Dry, mineral-matter-free basis.
** Moist, mineral-matter-free basis.
(1) Non-agglomerating; if agglomerating classified as low volatile bituminous.
(2) Commonly agglomerating.
(3) If agglomerating classified as high volatile C bituminous.
(4) Non-agglomerating.
VM : Volatile matter
FC : Fixed carbon

Source: See Table 1.

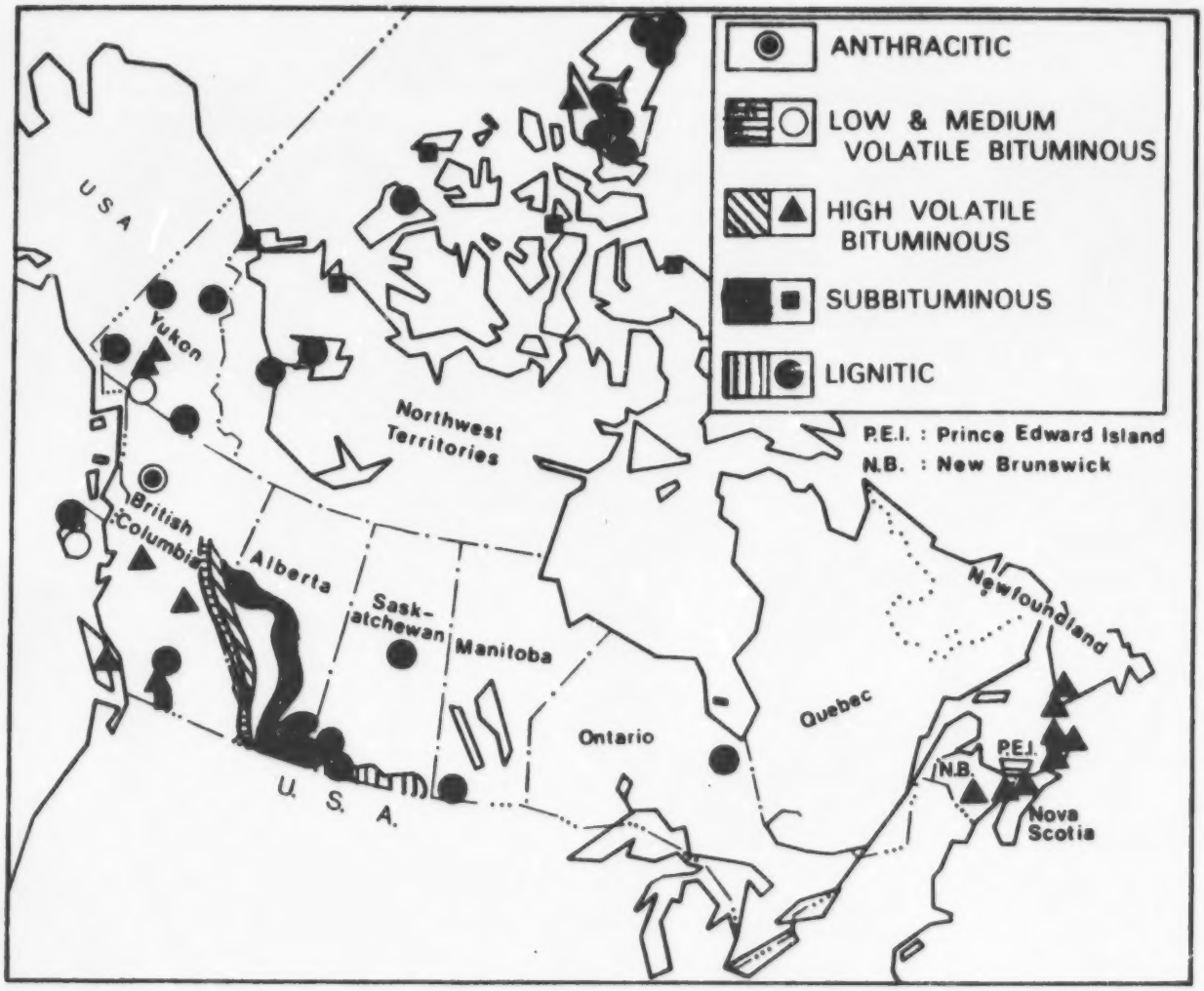


Figure 2 Occurrences of coal in Canada by rank.

Source: See Table 1

Table 2

SASKATCHEWAN COAL RESOURCES AND RESERVES - 1981
(10^9 tonnes)

COALFIELD	RESOURCES OF IMMEDIATE INTEREST	COAL IN MINEABLE SEAMS	RECOVERABLE COAL
Willow Bunch	1.791		
Wood Mountain	1.011		
Estevan	0.780		
Cypress	0.569		
Total	4.151	2.121	1.697

Source: EMR, Canada.

TABLE 3 REMAINING ESTABLISHED RESOURCES AND RESERVES OF COAL IN ALBERTA (10^9 tonnes)

	1	2	3	4	5
Rank	Region	Mineability	In-Place Resources	Reserves Mine Permit	Total
Low-and medium-volatile bituminous	Mountain	Surface	1.1		0.51
		Underground	5.5		1.10
			6.7	0.25	1.6
High-volatile bituminous	Mountain	Surface	0.08		0.03
		Underground	0.85		0.05
	Foothills	Surface	1.7		1.4
		Underground	.71		.19
	Plains	Surface	.01		0.00
		Underground	.75		0.19
			4.1	0.60	1.80
Sub-bituminous	Plains	Surface	12		7.1
		Underground	28		7.7
			40	0.90	15
Lignite	Plains	Surface	0.15		0.08
		Underground	0.35		0.04
			0.51	0.00	0.14
		TOTAL	52	1.7	18

Source: Energy Resources Conservation Board (ERCB), Reserves of Coal: Province of Alberta, Report ST 84-31, December, 1983.

COALFIELD	TYPE	MINING METHOD	RESERVES		RESOURCES
Southeast (Elk Valley, Crowsnest & Flathead)	Medium Volatile Bituminous	Open Pit & Underground	Metallurgical Thermal	1,030 .165	21,500 3,800
Peace River	Medium Volatile Bituminous to Low Volatile Bituminous	Open Pit & Underground	Metallurgical Thermal	.470 .105	6,900 1,200
Groundhog	Low Volatile Bituminous to Semi Anthracite	Open Pit & Underground	Thermal		4,800
Telkwa	High Volatile B Bituminous	Open Pit & Underground	Thermal		.088
Bowron River	High Volatile B Bituminous	Underground	Thermal		.020
Merritt	High Volatile B Bituminous	Underground	Thermal		.018
Hat Creek	Lignite to Sub Bituminous B	Open Pit	Thermal	.925	1,720
Similkameen	Lignite to High Volatile C Bituminous	Open Pit & Underground	Thermal	.015	.021
Comox	High Volatile A Bituminous	Open Pit & Underground	Thermal	.030	.154
Nanaimo	High Volatile B Bituminous	Underground	?		.007
			Total Metallurgical Total Thermal	1,500 1,240	28,600 11,800
				2,740	40,200

TABLE 4

BRITISH COLUMBIA COAL RESOURCES AND RESERVES
(10^9 tonnes)

SOURCE: B.C. Ministry of Energy and Natural Resources, Personal Communication with the Ministry, 1983.

TABLE 5

SALES AND VOLUMES

SASKATCHEWAN LIGNITE

(thousands of tonnes and thousands of dollars)

YEAR	VOLUME	SALES	AVERAGE VALUE ($)
1982	7,494	62,449	8.33
1981	6,798	42,061	6.19
1980	5,980	29,726	4.97
1979	5,012	20,475	4.06
1978	5,029	17,705	3.52
1977	5,476	20,335	3.71
1976	4,694	15,201	3.24
1975	3,549	9,239	2.60
1974	3,485	8,161	2.34
1973	3,656	8,500	2.33
1972	2,977	6,569	2.21
1971	2,996	6,405	2.02
1970	3,464	7,400	2.14
1969	1,831	3,727	2.03
1968	2,042	4,137	2.03
1967	1,814	3,621	2.00
1966	1,890	3,727	1.97
1965	1,915	3,730	1.95
1964	1,828	3,905	2.14
1963	1,700	3,714	2.19
1962	2,047	4,554	2.22
1961	2,004	4,510	2.25
1960	1,969	4,315	2.19

Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook, various years.

TABLE 6

SALES AND VOLUMES, ALBERTA SUBBITUMINOUS COAL

(thousands of tonnes and thousands of dollars)

YEAR	ALBERTA	OTHER PROVINCES	VALUE OF SALES	AVERAGE VALUE ($)
1981	11,144	77	69,993	6.24
1980	10,249	177	56,761	5.44
1979	9,226	181	44,723	4.75
1978	7,781	465	30,555	3.71
1977	7,223	447	23,611	3.08
1976	5,723	600	20,004	3.16
1975	5,212	768	17,687	2.96
1974	4,833	248	13,232	2.60
1973	4,370	110	11,349	2.53
1972	4,286	170	10,205	2.29
1971	3,881	126	7,000*	1.74
1970	3,271	283		
1969	2,710	183		
1968	2,409	279		
1967	1,803	610		

* Estimate from graph - ERCB, Review of the Alberta Coal Industry, forthcoming.

SOURCE: Alberta Economic Development, Alberta Industry and Resources, 1982.

TABLE 7

SALES AND VOLUMES, ALBERTA BITUMINOUS COAL

(thousands of tonnes and thousands of dollars)

YEAR	ALBERTA	OTHER PROVINCES	JAPAN	OTHER COUNTRIES	VALUE OF SALES	AVERAGE VALUE ($)
1981	543	1880	3022	1284	411,837	61.20
1980	432	1750	4084	1165	310,318	41.66
1979	147	1630	2522	110	202,280	39.36
1978	148	630	3841	575	216,233	41.63
1977	175	26	4007	44	192,382	45.23
1976	120	177	4361	111	214,657	45.02
1975	145	392	3551	58	162,357	39.16
1974	130	327	2672	207	71,421	21.42
1973	315	82	3453	213	49,500	12.19
1972	31	81	3285	4	38,613	11.35
1971	2	75	3029	89		11.00*
1970	2	35	2172	5		
1969	6	85	809	10		
1968	18	91	734	8		
1967	33	103	702	9		

* Estimate from graph - ERCB, Review of the Alberta Coal Industry, forthcoming.

SOURCE: See Table 6

TABLE 8

SALES[1] AND VOLUMES

ALBERTA COAL - ALL TYPES

(thousands of tonnes and thousands of dollars)

YEAR	SUBBITUMINOUS		BITUMINOUS		TOTAL		AVERAGE VALUE ($)
	VOLUME	SALES	VOLUME	SALES	VOLUME	SALES	
1981	11,221	69,993	6,729	411,837	17,950	481,830	26.84
1980	10,426	56,761	7,448	310,318	17,874	367,079	20.54
1979	9,407	44,723	5,139	202,280	14,546	247,003	16.98
1978	8,246	30,555	5,194	216,233	13,440	246,788	18.36
1977	7,670	23,611	4,253	192,382	11,923	215,993	18.12
1976	6,322	20,004	4,768	214,657	11,090	234,661	21.16
1975	5,980	17,687	4,146	162,357	10,126	180,044	17.78
1974	5,080	13,232	3,335	71,421	8,415	84,653	10.06
1973	4,480	11,349	4,062	49,500	8,542	60,849	7.12
1972	4,455	10,205	3,401	38,613	7,856	48,818	6.21
1971	4,008	-	3,196	-	7,204	-	
1970	3,553	-	222	-	3,775	-	
1969	2,893	-	911	-	3,804	-	
1968	2,689	-	852	-	3,541	-	
1967	2,412	-	845	-	3,257	-	

1. Not available prior to 1972

Source: Alberta Economic Development, Alberta Industry and Resources, 1982.

TABLE 9

SALES AND VOLUMES

B.C. COAL - ALL TYPES

(Thousands of tonnes and thousands of dollars)

YEAR	VOLUME	SALES[1]	AVERAGE VALUE[2] ($)
1982	10,646	556,878	52.31
1981	11,753	554,271	47.16
1980	10,824	461,493	42.64
1979	10,570	439,280	41.56
1978	9,464	381,895	40.35
1977	8,424	328,847	39.04
1976	7,538	298,684	39.63
1975	8,925	317,112	35.53
1974	7,757	154,594	19.93
1973	6,925	87,976	12.71
1972	5,467	66,030	12.08
1971	4,141	45,802	11.06
1970	2,399	19,560	8.16
1969	773	6,817	8.82
1968	870	7,589	8.72
1967	824	7,045	8.54
1966	772	6,196	8.02
1965	863	6,714	7.75
1964	827	6,328	7.65
1963	772	6,238	8.08
1962	749	6,134	8.19
1961	834	6,802	8.16
1960	715	5,242	7.32

1. Based on minehead value.

2. Average Value is calculated by B.C. Ministry of Energy, Mines and Petroleum Resources and is a weighted average value of prices received for coal sold. The result is equivalent to Sales ÷ Volume. F.O.B. mine

Source: B.C. Ministry of Energy, Mines and Petroleum Resources, Annual Report, 1979 and B.C. Minerals Quarterly, July 1983

TABLE 10

SALES AND VOLUMES

B.C. METALLURGICAL BITUMINOUS COAL

(thousands of tonnes and thousands of dollars)
(shares of metallurgical in total in parentheses)

YEAR	VOLUME	SALES	AVERAGE VALUE
1982	9,486 p (30.6)	..	59.00 p
1981	10,811 (82.0)	518,428 (93.5)	47.95
1980	9,654 (89.2)	423,128 (91.7)	43.83
1979	9,592 (90.7)	412,393 (93.9)	42.99
1978	8,530 (90.1)	361,255 (94.6)	42.35
1977	7,616 (90.4)	314,316 (95.6)	41.27
1976	6,824 (90.5)	283,754 (95.0)	41.58
1975	8,104 (90.8)	305,485 (96.3)	37.70
1974	7,279 (93.8)	149,026 (96.4)	20.47
1973	6,853 (99.0)	87,407 (99.4)	12.75

Sources: B.C. Ministry of Energy, Mines and Petroleum Resources, Annual Report, 1979.
: ——— B.C. Mineral Quarterly, July 1983.
: Personal communication with the Ministry

TABLE 11

SALES AND VOLUMES

B.C. THERMAL BITUMINOUS COAL

(thousands of tonnes and thousands of dollars)
(shares of thermal in total in parentheses)

YEAR	VOLUME	SALES	AVERAGE VALUE
1982	2,281 P (19.4)		37.00 P
1981	914 (8.0)	35,844	38.00
1980	1,169 (10.8)	38,365	32.81
1979	973 (9.3)	26,888	27.48
1978	934 (9.9)	20,640	22.10
1977	808 (9.6)	14,531	17.98
1976	713 (9.5)	14,930	20.94
1975	821 (9.2)	11,627	14.16
1974	496 (6.4)	5,568	11.23
1973	72 (1.0)	569	7.90
1972			
1971			
1970			

Resources: B.C. Ministry of Energy, Mines and Petroleum Resources, Annual Report, 1979.
Sources : ——— B.C. Mineral Quarterly, July 1983.
: Personal Communication with the Ministry

TABLE 12

MINERAL INDUSTRY VALUE ADDED

(TOTAL ACTIVITY)

(Millions of current dollars, percentage of Provincial mining total in parentheses)

YEAR	SASKATCHEWAN			SASK.&[1] ALBERTA	ALBERTA	BRITISH COLUMBIA	
	POTASH	URANIUM	OIL AND GAS	COAL	OIL AND GAS	COAL	OIL AND GAS
1982	488.5 (25.5)	162.4 (8.5)	1,162.4 (60.7)	310.1 (1.6)	16,848.7 (98.3)	380.2 (25.4)	736.0 (49.1)
1981	889.7 (44.9)	463.4[2] ( )	806.2 (40.6)	214.6 (1.3)	14,307.8 (98.5)	337.1 (20.7)	617.2 (37.9)
1980	900.4 (46.2)	198.5 (10.2)	780.3 (40.0)	231.7 (1.5)	13,497.6 (98.3)	274.7 (15.3)	528.4 (29.5)
1979	613.5 (39.2)	225.0 (14.4)	668.4 (42.7)	184.7 (1.4)	11,279.8 (98.3)	373.6 (19.5)	537.5 (28.1)
1978	360.2 (28.0)	234.6 (18.3)	645.2 (50.2)	187.7 (1.8)	8,923.3 (97.9)	294.5 (24.9)	428.5 (36.2)
1977	301.4 (30.4)	N/A	546.4 (55.1)	149.1 (1.7)	7,685.5 (98.0)	271.1 (25.1)	408.8 (37.8)
1976	262.1 (33.5)	.	412.0 (52.6)	176.7 (2.5)	6,152.9 (97.1)	232.6 (22.9)	444.1 (43.8)
1975	298.5 (39.7)	.	401.3 (53.4)	157.9 (2.6)	5,191.3 (96.8)	273.5 (34.6)	201.1 (25.4)
1974	232.7 (34.7)	.	391.0 (58.3)	80.3 (1.6)	4,126.0 (97.9)	118.8 (15.0)	171.1 (21.5)
1973	129.0 (30.0)	.	254.6 (59.3)	86.8 (2.4)	2,491.8 (97.7)	63.2 (8.2)	113.3 (14.7)
1972	112.3 (31.5)	.	209.2 (58.7)	43.8 (2.0)	1,748.4 (97.3)	44.5 (11.5)	105.0 (27.2)
1971	107.9 (30.9)	.	213.2 (61.1)	33.8 (1.8)	1,448.9 (97.5)	22.9 (7.2)	96.1 (30.3)
1970	87.5 (26.9)	.	194.7 (59.9)	25.5 (1.6)	1,239.1 (97.8)	5.6 (1.8)	90.6 (28.6)

Sources: Statistics Canada 26-213 Crude Petroleum and Natural Gas
Statistics Canada 26-206 Coal Mines
Statistics Canada 26-201 General Review of the Mineral Industries
Statistics Canada 26-224 Non Metal Mines
Statistics Canada 26-223 Metal Mines

Notes: N/A - not available.
1. Sask. & Alberta data not available by Province.
2. significant revisions were not reported by Province by Statistics Canada and therefore considerable error exists in this datum.

TABLE 13 PER CAPITA VALUE ADDED

MINING INDUSTRIES

(CURRENT DOLLARS)

	ALL MINING				OIL AND GAS				COAL			POTASH	
YEAR	CANADA	SASKATCHEWAN	ALBERTA	B.C.	CANADA	SASKATCHEWAN	ALBERTA	B.C.	CANADA	SASK.& ALBERTA	B.C.	CANADA	SASKATCHEWAN
1982	992	1,954	7,396	537	767	1,187	7,272	264	34	94	136	20	499
1981	949	2,049	6,527	593	654	833	6,432	225	28	67	123	37	919
1980	967	2,033	6,415	672	620	914	6,304	194	26	75	103	37	939
1979	837	1,647	5,586	738	529	703	5,494	203	28	61	144	26	645
1978	638	1,363	4,594	466	429	684	4,500	168	24	64	116	15	382
1977	569	1,060	4,099	433	374	584	4,018	162	22	52	108	13	322
1976	494	850	3,448	411	307	447	3,348	179	21	64	94	11	285
1975	430	829	3,016	325	257	442	2,920	83	21	59	112	13	329
1974	399	745	2,447	334	211	434	2,396	73	12	31	50	10	259
1973	285	475	1,509	336	131	281	1,474	50	8	22	27	6	143
1972	197	390	1,084	172	96	229	1,055	48	6	17	20	5	123
1971	177	377	913	145	83	230	890	45	5	13	10	5	117
1970	180	346	794	149	73	207	777	43	3	10	3	4	93

Sources: Table 12.

Statistics Canada 91-201, Population of Canada by Province.

T A B L E 1 4

PROVINCIAL REVENUE FROM SELECTED MINERALS

(millions of $'s)
(percent of revenue from all minerals in parentheses)

	SASKATCHEWAN[1]			ALBERTA[2]			B C[3]		
	1970	1974	1982	1970	1974	1982	1970	1974	1982
Oil & Gas	29 (85)	56 (60)	776 (85)	N/A	505 (87)	4,784 (95)	N/A	49 (74)	76 (77)
Potash	3 (8)	35 (37)	81 (9)	n/a	n/a	n/a	n/a	n/a	n/a
Coal	- (-)	1 (1)	8 (1)	N/A	4 (1)	16 (-)	N/A	4 (6)	17 (18)
Uranium	N/A	N/A	28 (3)	n/a	n/a	n/a	n/a	n/a	n/a
All Minerals	34	93	901	N/A	578	5,016	N/A	66	98

Notes:

N/A not available
n/a not applicable
(-) less than 1% when rounded
1. 1982 was a particularly bad year for potash while 1981 revenues were $264.7 million and 34% of total revenues
2. These are fiscal years.
3. Revenues collected under the Mining Tax Act (a profits tax) in B.C. are not included here but revenues are small

Sources: Saskatchewan Energy and Mines, Mineral Statistics Yearbook, various years.
Alberta Economic Development, Alberta Industry and Resources, 1982.
B.C. Ministry of Energy, Mines and Petroleum Resources, Annual Report, 1979, as well as personal communication with the Ministry.

TABLE 15

EMPLOYMENT

(Mining Activity)

	CANADA			SASKATCHEWAN		ALBERTA		SASK. & ALBERTA			BRITISH COLUMBIA		
	MINING INDUSTRIES	OIL AND GAS	COAL	MINING INDUSTRIES	OIL AND GAS	MINING INDUSTRIES	OIL AND GAS	MINING INDUSTRIES	OIL AND GAS	COAL	MINING INDUSTRIES	OIL AND GAS	COAL
1982	74958	7568	10281	5001	407	8678	6048	13679	6455	2685	10546	292	3074
1981	81136	6696	9188	5848	381	7960	5316	13808	5697	2701	10897	192	2767
1980	80066	6401	9428	5298	455	7928	5044	13276	5499	2884	9829	220	2683
1979	72580	5764	8642	4859	392	7313	4805	12172	5197	2390	8858	294	2633
1978	70306	5425	8771	4672	396	7135	4468	11807	4864	2592	8600	281	2246
1977	79902	5191	8488	4525	315	6839	4347	11364	4662	2373	9008	271	2295
1976	78989	4931	7777	4213	324	6378	4032	10591	4356	2226	8403	298	2058
1975	77091	4679	6696	4003	307	5894	3798	9897	4105	1903	8981	304	2386
1974	79928	4845	6430	3952	414	5430	3804	9382	4218	1460	9607	304	2122
1973	75165	4404	6445	3372	465	5038	3402	8410	3867	1542	9379	274	1908
1972	73044	4324	6552	3344	452	5166	3301	8510	3756	1703	8241	289	1556
1971	76701	4082	6343	3414	463	5060	3106	8474	3569	1833	7765	301	1351
1970	77208	3796	6065	3020	443	4514	2822	8334	3265	1559	6890	274	951

Sources: Statistics Canada Publication

26-201, 26-206, 26-213

TABLE 16

FUEL INDUSTRY EMPLOYMENT SHARES OF TOTAL MINING INDUSTRIES

(Mining Activity)

(%)

	CANADA		SASK. & ALBERTA		B.C.	
	OIL AND GAS	COAL	OIL AND GAS	COAL	OIL AND GAS	COAL
1982	10	14	47	20	3	29
1981	8	11	41	20	2	25
1980	8	12	41	22	2	27
1979	8	12	43	20	3	30
1978	8	12	41	22	3	26
1977	6	11	41	21	3	25
1976	6	10	41	21	4	24
1975	6	9	41	19	3	27
1974	6	8	45	16	3	22
1973	6	9	46	18	3	20
1972	6	9	44	20	4	19
1971	5	8	42	22	4	17
1970	5	8	39	19	4	14

Source: Table 15.

TABLE 17

COAL MINES
VALUE ADDED PER WORKER
(Thousands of current dollars)

	CANADA	SASK. & ALBERTA	B.C.
1982	81.5	115.5	123.7
1981	73.1	79.5	121.8
1980	65.9	80.3	102.4
1979	76.2	77.3	141.9
1978	64.6	72.4	131.1
1977	59.9	62.8	118.1
1976	61.0	79.4	113.0
1975	72.2	83.0	114.6
1974	37.2	55.0	56.0
1973	25.9	56.3	33.1
1972	19.9	25.7	28.6
1971	16.3	18.4	16.9
1970	12.1	16.4	5.9

Source: Tables 12 and 15.

TABLE 18

COAL PRICES (Index: 1971 = 100)

YEAR	SASKATCHEWAN[1] LIGNITE	ALBERTA[2] SUBBITUMINOUS	ALBERTA[2] BITUMINOUS	BRITISH[3] COLUMBIA
1983				
1982	8.33(412.4)			52.31(473.0)
1981	6.19(306.4)	6.24(358.6)	61.20(556.4)	47.16(426.4)
1980	4.97(246.0)	5.44(312.6)	41.66(378.7)	42.64(385.5)
1979	4.09(202.5)	4.75(273.0)	39.36(357.8)	41.56(375.8)
1978	3.52(174.3)	3.71(213.2)	41.63(378.5)	40.35(364.8)
1977	3.71(183.7)	3.08(177.0)	45.23(411.2)	39.04(353.0)
1976	3.24(160.4)	3.16(181.6)	45.02(409.3)	39.63(358.3)
1975	2.60(128.7)	2.96(170.1)	39.16(356.0)	35.53(321.2)
1974	2.34(115.8)	2.60(149.4)	21.42(194.7)	19.93(180.2)
1973	2.33(115.3)	2.53(145.4)	12.19(110.8)	12.71(114.9)
1972	2.21(109.4)	2.29(131.6)	11.35(103.2)	12.08(109.2)
1971	2.02(100.0)	1.74(100.0)	11.00(100.0)	11.06(100.0)
1970	2.14(105.9)			8.16(73.8)
1969	2.03(100.5)			8.82(79.7)
1968	2.03(100.5)			8.72(78.8)
1967	2.00(99.0)			8.54(77.2)
1966	1.97(97.5)			8.02(72.5)
1965	1.95(96.5)			7.75(70.1)
1964	2.14(105.9)			7.65(69.2)
1963	2.19(108.4)			8.08(73.1)
1962	2.22(109.9)			8.19(74.1)
1961	2.25(111.4)			8.16(73.8)
1960	2.19(108.4)			7.32(66.3)

[1] Average value FOB minesite per metric tonne. Value of Mineral Production used for pre-1973 calculations.

[2] Average annual value per tonne.

[3] Weighted price of all sales.

SOURCES: Tables 5, 6, 7, and 9.

TABLE 19

PRICE INDEXES

(1971 = 100)

	Mfg Selling Price	CPI	Imported Oil Price	Average Oil wellhead Price	Potash	Uranium	Lignite coal	Alberta subbituminous coal	Alberta bituminous coal	B.C. bituminous coal
1962	83	76	103	81	102	141	110	N/A	N/A	74
1967	90	87	94	89	77	71	99	N/A	N/A	77
1972	105	105	110	101	97	100	109	132	103	109
1977	174	161	646	367	173	226	184	177	411	353
1982	289	263	1839	896	312	519	413	359*	556*	473
Percentage Change										
1962-1972	25	38	R	24	-4	-29	-1	-	-	48
1972-1982	177	151	1560	789	221	419	277	173	439	333
1962-1982	247	246	1689	1004	208	470	275	-	-	539

Notes: These are Average Values of Sales F.O.B. minesite - excluding transport costs to market
*1981 figures

Source: Saskatchewan Energy and Mines, Mineral Statistics Yearbook, various years
Alberta, Energy Resources Conservation Board, Review of the Alberta Coal Industry, forthcoming.
Alberta Economic Development, Alberta Industry and Resources, 1982
B.C. Ministry of Energy, Mines and Petroleum Resources, Annual Report, 1979
B.C. Mineral Quarterly, Statistics and Information, July, 1983.
Personal Communication with the provincial mines departments.
Statistics Canada Publications, 65-203, Merchandise Trade Imports and 62-011 Industry Price Indexes and Canadian Petroleum Association, Handbook.

TABLE 20

WORLD COAL RESOURCES AND RESERVES

MAJOR COAL-PRODUCERS

(mtce[1])
(% shares of total in parentheses)

COUNTRY [2]	GEOLOGICAL RESOURCES		TECHNICALLY AND ECONOMICALLY RECOVERABLE RESERVES	
United States	2,570,398	(24)	166,950	(25)
Soviet Union	4,860,000	(45)	109,900	(17)
People's Republic of China	1,438,045	(13)	98,883	(15)
Poland	139,750	(1)	59,600	(9)
United Kingdom	190,000	(2)	45,000	(7)
Republic of South Africa	72,000	(1)	43,000	(6)
Federal Republic of Germany	246,800	(2)	34,419	(5)
Australia	600,000	(6)	32,800	(5)
India	81,019	(1)	12,427	(2)
Canada	323,036	(3)	4,242	(1)
Others	229,164	(2)	55,711	(8)
TOTAL WORLD	10,750,212	(100)	662,932	(100)

[1] mtce: million metric tons (tonnes) of coal equivalent where specific heating value of each tonne in this table is standardized to equal 7,000 kcal/kg or 12,600 btu/lb. When heat content is less in a tonne as for subbituminous coals, more than one tonne by volume is required to equal one tonne of coal equivalent for this table.

[2] Countries are ranked by size of reserves

Source: Carroll L. Wilson, World Coal Study: Coal - Bridge to the Future Cambridge, Massachusetts, U.S., Ballinger, 1980. pp. 161.

TABLE 21

WORLD COAL PRODUCTION 1977

(mtce)

COUNTRY/REGION	PRODUCTION	% SHARE OF TOTAL	RANK
Canada	23	.9	(-)
U.S.	560	22.9	1
North America	583	23.8	
France	21	0.9	
Federal Republic of Germany	120	4.9	5
United Kingdom	108	4.4	6
Other Western Europe	38	1.6	10
Total OECD Europe	278	11.7	
Japan	18	0.7	
Australia	76	3.1	7
Total OECD	964	39.3	
Republic of South Africa	73	3.0	8
India	72	2.9	9
East and Other Asian Countries	15	0.6	
Africa and Latin America	25	1.0	
People's Republic of China	373	15.2	3
Poland	167	6.8	4
Soviet Union	510	20.3	2
Other centrally planned	250	10.2	
Total Other Regions	1,485	60.6	
TOTAL WORLD	2,450	100.0	

Source: World Coal Study, see Table 20.

TABLE 22

WORLD COAL IMPORTS 1977

(mtce)

COUNTRY/REGION	METALLURGICAL COAL	% SHARE	STEAM COAL	% SHARE
Denmark	-		4.6	7.7
Finland	0.9	0.6	4.1	6.8
France	10.0	7.7	14.0	23.3
Federal Republic of Germany	1.0	0.8	3.0	5.0
Italy	11.1	8.5	2.0	3.3
Netherlands	3.0	2.3	1.5	2.5
Sweden	1.8	1.4	0.3	0.5
United Kingdom	1.0	0.8	1.0	1.7
Other Western Europe	6.0	4.6	7.0	11.7
OECD Europe	35.0	26.9	37.0	61.7
Canada	7.0	5.4	6.0	10.0
Japan	60.0	46.2	2.0	3.3
Total OECD	100.0	76.9	45.0	75.0
East and Other Asia	3.0	2.3	-	-
Africa and Latin America	7.0	5.4	1.0	1.7
Centrally Planned Economics	18.0	13.8	17.0	28.3
Total World [1]	130.0		60.0	

1. Totals do not add due to rounding in source.

Source: World Coal Study, see Table 20.

TABLE 23

Japanese suppliers of coking coal

	1970		1975		1978		1979		1980		1981	
	million tonnes	million yen	million tonnes	million yen	million tonnes	million yen	million tonnes	million yen	million tonnes	million yen	million tonnes	million yen
Australia	16.5	88 708	22.7	268 655	24.5	296 167	26.0	320 820	25.9	347 958	29.2	420 878
US	25.3	224 281	22.4	499 775	8.8	134 158	13.4	221 806	19.3	350 798	21.5	396 183
Canada	3.2	18 834	10.6	157 963	10.9	133 113	10.4	131 864	10.5	148 707	9.6	135 920
South Africa	.0	142	.0	1 181	2.3	22 049	2.3	22 897	2.9	34 734	3.0	41 466
USSR	2.8	6 869	3.0	19 779	2.1	14 979	2.1	14 911	1.9	12 128	1.4	9 391
TOTAL	48.8	353 882	60.6	1 000 748	50.2	629 769	56.1	746 161	61.9	925 984	65.7	1 030 859
Canadian Market Share	6.56%	5.32%	17.5%	15.7%	21.7%	21.1%	18.5%	17.7%	16.9%	16.1%	14.6%	13.1%

SOURCE: Japan Tariff Association; Japan Exports and Imports, various issues

TABLE 24

Indicative Steam Coal Costs and Prices
($ U.S. 1979 per metric ton)

	Price FOB Mine	Mine to Port	Price* FOB Port	Port Loading	Ocean Freight	Port Unloading	Delivered Price Range	Avg.	$/MBTU
To: *NW Europe*									
From: *United States*									
East—Underground	20-35	10-15	30-45	1-2	6-10	2	39-59	49	1.85
West—Surface	8-18	10-20	20-35	1-2	8-11	2	31-50	41	2.19
Canada									
West—Surface	15-20	10-20	25-35	1	8-12	2	36-50	42	1.92
Australia									
Underground	15-25	5-10	20-25	2	10-14	2	34-43	39	1.63
Surface	12-20	5-10	18-25	2	10-14	2	32-43	38	1.52
South Africa									
Underground	10-15	5-7	15-22	1	8-10	2	26-35	31	1.41
Poland									
Underground			23-31	1	5	2	31-39	35	1.46
To: *Japan*									
From: *United States*									
East—Underground	20-35	10-15	30-45	1-2	11-15	2	44-64	54	2.05
West—Surface	8-18	10-20	20-35	1-2	9-12	1	31-50	40	2.00
Canada									
West—Surface	15-20	10-20	25-35	1	8	1	35-45	40	2.00
Australia									
Underground	15-25	5-10	20-25	2	6-8	1	29-36	33	1.38
Surface	12-20	5-10	18-25	2	6-8	1	27-36	32	1.33
South Africa									
Underground	10-15	5-7	15-22	1	9	1	26-33	30	1.36
Poland									
Underground			23-31	1	11-13	1	36-44	40	1.67

* As mine prices and transport costs are given as ranges, FOB port prices are not necessarily the direct sum of the range limits.

Source: U.S. Department of Energy, *Coal Export Study* (1979), page 9, Table 4.

Source: World Coal Study, pp. 126

TABLE 25

RAIL CHARGES FOR MINE TO PORT FOR PACIFIC RIM COAL SUPPLIERS (MID 1982)

	AREA DISTANCE FROM TERMINAL (KM)	TERMINAL	RAIL RATE ($/TONNE)	RAIL (c/TONNE-KM)
CANADA	S.E., B.C. (1,160)	ROBERTS BANK	22.20	1.9
	HINTON, ALBERTA (1,120)	ROBERTS BANK	21.10	1.9
U.S.	UTAH (1,280)	LOS ANGELES	26.20	2.0
	COLORADO (2,000)	LOS ANGELES	37.20	1.9
AUSTRALIA	QUEENSLAND/ NSW (160-400)	GLADSTONE NEWCASTLE	(11.80-12.50)	3.1 - 7.4
SOUTH AFRICA	TRANSVAAL (480)	RICHARDS BAY	10.60	2.2

Source: Dr. James A.L. White, Byron Creek Collieries Ltd. (ESSO Minerals Canada) paper presented to CIM Coal Symposium Calgary, May 1980

TABLE 26

COAL EXPORT FORECASTS

(millions of metric tonnes)

		THERMAL EXPORTS Total	THERMAL EXPORTS Japan	METALLURGICAL EXPORTS Total	METALLURGICAL EXPORTS Japan	TOTAL COAL Total	TOTAL COAL Japan
1982	1. B.C.	1.2	0.2	8.7	6.4	9.9	6.6
	2. Alberta	1.4	1.1	3.7	3.1	5.1	4.2
	Total West	2.6	1.3	12.4	9.5	15.0	10.8
	14. Canada					16.0	
1985	3. B.C.	6-8	1-2	17-20	12-14	23-28	13-16
	4. Total West					23	
	4. Canada					24	
	5. Canada					32	
	6. Canada	10		24		34	
	7. Canada					40	
	8. Canada					31	
	9. Canada					25	
	10. Canada			20	15		
	11. Canada		6-8		13		18-20
	12. Canada	7					
	13. Canada					20	
	14. Canada					20	
1990	3. B.C.	9-16	2-4	21-23	13-14	30-39	15-18
	3. Alberta	18		9		26	
	4. West					26-36	
	5. Canada					46-72	
	6. Canada	14		27		41	
	7. Canada					53	
	8. Canada					46	
	9. Canada					43	
	10. Canada			22	16		
	11. Canada		14-16		15		29-31
	12. Canada	21					
	13. Canada					25-35	
	14. Canada					25	
	15. West		8-10				10-20
1995	4. West					47	
	6. Canada	17		33		50	
	13. Canada					35-50	
	14. Canada					35	
2000	3. Alberta	24		9		32	
	4. West					56	
	6. Canada	22		43		65	
	12. Canada	29					
	13. Canada					34-59	18-25
	14. Canada					34	

Table 26 - continued

Note: All figures in original sources have been rounded.

Sources:

1. Statistics Canada, 45-002, Coal and Coke Statistics

2. ERCB, Alberta Coal Industry, Annual Statistics, 1982

3. Tricia Gibson, "Development Options for Alberta and Saskatchewan Coal", CERI paper 83-2, 1983.

   Kristi E. Varangu, "Development Options for British Columbia Coal", CERI paper 83-3, 1983

4. Canada West Foundation, Western Canada's Coal: The Sleeping Giant, Calgary, 1980

5. Crows Nest Resources, 1981 (Provided by Coal Association)

6. The Coal Association of Canada - submission to the National Energy Board Supply and Demand Hearings, 1980

7. Coal Association of Canada 1981 (provided by the Association)

8. The Coal Association of Canada, Toward a Comprehensive Solution, Statement to the House of Commons Transportation Committee regarding the Western grain transportation Act, Bill C-155, 1983

9. Chase Econometrics, 1982

10. Crows Nest Resources, paper given by Dr. Roger J. Goodman to the CIE/CIM Coal Symposium, Calgary, May 1983

11. Econolynx estimates as contained in - Keith A.J. Hay et al, Canadian Coal for Japan, Canada-Japan Trade Council, Ottawa, 1982

12. Byron Creek Collieries Ltd., paper given by Dr. James A.L. White to the CIE/CIM Coal Symposium, Calgary, May 1983.

13. World Coal Study, Coal-Bridge to the Future, Ballinger, Cambridge, Mass., 1980 and Country Studies - same report

14. Alf Darragh, Energy Mines and Resources Canada, "Demand and Production of Coal in Canada", paper forthcoming in CIM publication reviewing coal in Canada

15. ERCB, Review of the Alberta Coal Industry, forthcoming

TABLE 27

COAL EXPORT FORECASTS

RANGES

(millions of metric tonnes)

		THERMAL EXPORTS		METALLURGICAL EXPORTS		GRAND TOTAL	
		Total	Japan	Total	Japan	Total	Japan
1982	B.C.	1.2	0.2	8.7	6.4	9.9	6.6
	Alberta	1.4	1.1	3.7	3.1	5.1	4.2
	West	2.6	1.3	12.4	9.5	15.0	10.8
	Canada					16.0	
1985	Canada	7-10	6-8	20-24	13-15	20-40	18-20
1990	Canada	14-34	8-16	22-32	14-18	25-72	22-31
1995	Canada	17*	N/A	33*	N/A	35-50	N/A
2000	Canada	22-29		43*	N/A	32-59	18-25*

1. The estimates for Canada can be assumed to apply to the West since exports from the East will continue to be small.
2. * denotes - only one forecast available.
3. N/A denotes - no forecast available.
4. The 'Grand Total' column is not necessarily a sum of the other total columnssince some sources provided only forecasts for total coal and not for both thermal and metallurgical.

Source: See Table 26

TABLE 28

COAL PRODUCTION CAPACITY

FOR EXPORT MARKETS

(millions of tonnes)

	1983		1985	
	METALLURGICAL	THERMAL	METALLURGICAL	THERMAL
Alberta	5.7	3.0	8.1	11.0
B.C.	13.1	3.4	20.4	6.3
West	18.8	6.4	28.5	17.3
Total Western Coal	25.2		45.8	

Note: The 1983 Capacities are those available for the most part in 1982 and therefore are comparable to sales volumes for 1982.

Sources: Estimates based on capacity as reported by ERCB in Alberta, CERI 1983 reports on development options in Alberta and B.C. and Dr. Roger J. Goodman, Crows Nest Resources in May 1983.

Appendix

Mathematical Note: Optimal Tax for Supplier.

The optimal tax of a seller facing a monopsonist depends on the behavior of the monopsonist so we first consider the maximizing behavior of a monopsonist whose price-setting behavior can be influenced by a supplier's tax. For the monopsonist

$$\pi = p \cdot x(L) - L \cdot s(L)$$

where: π is monopsony profit from sales in his competitive output market;

p is output price;

x is quantity of output which is a function of L;

L is the input which can be coal;

$s(L)$ is the inverse supply function of the input.

Maximizing over L implies

$$p \cdot x'(L) - s(L) - Ls'(L) = 0$$

or

$$VMP = MFC$$

which we used earlier in our diagrams. Now let a per unit constant tax of "v" apply to the input so that the supply function becomes

$$s = s(L) + v$$

The first order condition becomes

$$p \cdot x'(L) - s(L) - v - Ls'(L) = 0$$

and finding the change in L in response to a tax we have

$$p \cdot x''dL - s'dL - dv - Ls''dL - s'dL = 0$$

$$[p \cdot x'' - s' - Ls'' - s']dL - dv = 0$$

$$\frac{dL}{dv} = \frac{1}{p \cdot x'' - s' - Ls'' - s'}$$

$$= 1/ \frac{\partial^2 (\text{Profit})}{\partial L^2}$$

the denominator is <0 for profit max and therefore

$$\frac{dL}{dv} < 0$$

Solving for ds/dv we have

$s = s(L) + v$ which is the supply function and

$$\frac{ds}{dv} = s' \frac{dL}{dv} + 1$$

Incorporating our solution for dL/dv we have

$$\frac{ds}{dv} = s' \frac{1}{\frac{\partial^2(\text{Profit})}{\partial L^2}} + 1$$

The sign of ds/dv is ambiguous and depends on whether

$$\frac{s'}{\frac{\partial^2(\text{Profit})}{\partial L^2}}$$

is less than, greater than, or equal to one.

As a result we do not know how price paid for the input will change if a tax is imposed. It will depend on the relative sizes of s' and $\partial^2 \text{Profit}/\partial L^2$ or, in other words on the specific characteristics of both supply and demand. Only empirical studies can determine the result.

Secondly consider the seller's problem of determining an optimal tax. We can represent the response of the monopsonist within this problem by using the results of above, namely, dL/dv < 0 and ds/dv unknown.

The seller's goal is to max R where

$$R = sL - c(L)$$

where: $c(L)$ are producer costs;

s and L are functions of v.

Maximizing over v implies

$$s'(v)L(v) + [s(v) - c'(L)]L'(v) = 0$$

where $s'(v) \equiv ds/dv$ and $L'(v) \equiv dL/dv$ from above.

From the supply curve we know

$$s(v) = c'(L) + v$$

substituting into the above we have

$$s'(v)L(v) + vL'(v) = 0$$

$$\therefore v^* = \frac{-s'(v)L(v)}{L'(v)}$$

where $L'(v) < 0$

If $s'(v) > 0$ then $v^* > 0$ (tax)

and if $s'(v) < 0$ then $v^* < 0$ (subsidy)

In conclusion, a supplier tax will be optimal if the monopsonist raises price in response to the tax while a subsidy will be optimal if the monopsonist's response to a tax would be to lower price. When $s'(v)<0$ then it is optimal to reduce v and induce a price rise.

Glossary

1. General Terms

Bituminous Coal - refers to either coking coal when its a low volatile, agglomerating coal of high fixed carbon content or it refers to thermal coal of high calorific content when it is non-agglomerating and composed of high volatile matter. See Figure 1 and Table 1.

Clean coal - The product of a coal processing plant following preparation of the raw coal.

Coking coal - Coal with agglomeration qualities suitable for input to steelmaking.

Lignite coal - A non-agglomerating coal used for thermal generation - see Figure 1 and Table 1.

Metallurgical coal - Also called coking coal - see coking coal.

Monopsony - A market structure composed of one buyer and many sellers where the single buyer is referred to as a monopsonist. This is an extreme case while the more realistic situation is one where there are few buyers facing relatively more sellers in a market. This is called an oligopsony.

Raw coal - Coal as loaded in the pit or mine.

Tonne - Metric tonne used for all measurement of coal in this paper.

Subbituminous coal - A non-agglomerating coal used for thermal generation purposes - see Figure 1 for calorific value and Table 1 for a general description.

2. Resources and Reserves

The terminology used to describe stocks of coal in the ground vary slightly according to source. The following terms taken from the ERCB's, Reserves of Coal, Province of Alberta are generally applicable to all figures used in this report.

Resource - A gross quantity of coal calculated, interpreted, or presumed to exist in the ground.

Established resource - A body of coal that has been specifically delineated by drilling, trenching, driving adits, mine development operations or other exploratory work, but including some judged to exist continguously on the basis of geological, seismic, or simlar information.

Reserve - That portion of an established resource considered recoverable by current technology under present or anticipated economic and social conditions.

Initial in-place - The quantity of a resource prior to any production.

Initial reserve - A reserve prior to deduction of any production.

Remaining reserve - The initial reserve less cumulative production.

Ultimate potential - An estimate of the initial reserves which will have become developed in an area by the time all exploratory and development activity has ceased, having regard for the geological prospects of that area and anticipated technological, economic, and social conditions. Ultimate potential includes cumulative production, remaining reserves and presumed future additions through extensions and revisions of existing deposits, and the discovery or delineation of new deposits.

Footnotes

1. The term 'reserves' refers to that portion of the resource base of a mineral which is known to exist with greatest confidence and is available for production at current market prices.
2. For precise definitions of terminology see the Glossary.
3. Coking or metallurgical coal is an important input to the production of steel while thermal coal, as its name suggests, is an energy source used in the generation of electricity.
4. Figures 1 and 2 and Table 1 describe the coal and show its location in Canada.
5. Also called calorific value. Measured in Btu per lb or MJ/kg.
6. EMR, Canada, Coal Resources and Reserves of Canada, Report ER79-9, Tables 4 and 6.
7. Lignite also occurs in the southeast corner of the province in the Cypress Hills area.
8. The coal policy indicates protected areas of the province where coal developments are considered too costly from a social perspective.
9. The Federal government estimate of reserves uses the ERCB estimates but EMR reports quantities according to different terminology but in essence indicates that over 1.4×10^9 tonnes of Alberta coal is recoverable coal. This estimate meets similar economic and social criteria to that used by the ERCB in their estimate of recoverable reserves within mine permit boundaries.
10. One new hydro plant is under construction already and will start up in 1986.
11. These volumes are of raw coal before cleaning. The composition of coal production in 1982 and earlier was reversed with coking bituminous production less than thermal bituminous.

12. ERCB, Alberta Coal Industry, Annual Statistics, 1983.

    ____, Review of the Alberta Coal Industry, Forthcoming.

13. Varangu, Kristi E., "Development Options for British Columbia Coal", Canadian Energy Research Institute, Calgary, Alberta, 1983. Working Paper 83-3., p. 18.

14. This, of course, has been a general result for potential liquefaction and gasification projects.

15. Ontario Hydro's diversification strategy followed the 1973 oil crisis when there were fears that the U.S. would limit exports of its relatively cheaper coal to Ontario.

16. Coal's value may be underestimated using the value-added comparison since coal used in thermal plants is valued at cost of production rather than at market prices.

17. See Statistics Canada Catalogue 13-213 for Provincial GDP using Experimental Data and 26-206 for Coal Mine Value-Added.

18. Excluding income taxes.

19. Freehold oil and gas is taxed.

20. ERCB, forthcoming, Page 3-3.

21. These are just rough indicators since the production figures are really sales figures and employment includes above-ground administrative workers.

22. F.O.B. the Vancouver terminals.

23. See Coal Age issues over the past three years including the following articles: "Japan Pays Less", Coal Age, September 1983, p. 57, and "Pittston-Nippon Metallurgical Deal Puts Screws on Market", Coal Age, January, 1984, p. 27. Also see Coal Mining, January 1985, p. 30.

24. International prices found in: IEA Coal Research, Economic Assessment Service, Inflation and the Real Cost of Energy, December, 1980.

25. These estimates are based on total Western bituminous coal exports to Japan, most of which was metallurgical coal over the 1972-1981 period.

26. Dr. Roger J. Goodman, Crowsnest Resources, Mimeo, May 1983.

27. IEA Coal Research, Economic Assessment Service, Inflation and the Real Cost of Energy, IEA, December, 1980.

28. ERCB, forthcoming.

29. See the recommendations of the Advisory Body on Foreign Coal of the Japanese Agency of Natural Resources and Energy as discussed in Keith Hay et al, Canadian Coal for Japan, Ottawa, Canada - Japan Trade Council, 1982.

30. This very simple model abstracts from the use of other inputs in steel production in order to illustrate a basic point using geometry. For an algebraic illustration for 2 or more inputs see C.E. Ferguson and J.P. Gould, Microeconomic Theory, 5th edition, (Illinois, Richard D. Irwin, Inc., 1980).

31. For example see, James Brander and Slobodan Djajic, May 1983, and James A. Brander and Barbara J. Spencer, 1983.

32. Personal communication with provinces.

33. Based on conversations with Alberta Research Council Officials. Also, given real price declines for oil, liquefaction plants remain uncompetitive and the abundance of natural gas in the West renders the gasification of coal an unlikely option for some time and at least well into the next century.

34. Underpricing of domestic oil in Canada for the past decade has led to extensive discussion of the distortions imposed on the economy through pricing below opportunity costs. The arguments against underpricing coal are the same.

35. If coordination is not possible then provinces must resort to the policy tools which are within their power. As a result, taxation policies can be required to not only raise revenues for the provinces but also have the secondary effect of regulating the size of the industry. This must be done to protect provincial income generation.

36. A Benefit-Cost Analysis of the North East Coal Development provides sensitivity analysis for the new Peace River coalfield developments. If further coal development does not occur in 1990 then there are provincial losses associated with the infrastructure cost of providing highways, port, townsite, and the Tumbler Ridge Branchline. If the real price of coal does not rise after 1986 then the province's net losses on infrastructure will not be offset by the benefits of the project from such things as tax revenue. See pages 152-166. Also see John R. Livernois, 1980.

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